

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
22 August 2002 (22.08.2002)

PCT

(10) International Publication Number
WO 02/064571 A1

(51) International Patent Classification⁷: C07D 239/28,
A61K 31/505, C07D 405/12, 401/12, 409/12, 413/12,
417/12, A61P 19/02

(74) Agents: LUMB, J., Trevor et al.; Pfizer Inc., 201 Tabor
Road, Morris Plains, NJ 07950 (US).

(21) International Application Number: PCT/IB02/00190

(22) International Filing Date: 18 January 2002 (18.01.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/268,779 14 February 2001 (14.02.2001) US

(71) Applicant (for all designated States except US):
WARNER-LAMBERT COMPANY [US/US]; 201
Tabor Road, Morris Plains, NJ 07950 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **BARVIAN, Nicole,**
Chantel [US/US]; Pfizer Global Research & Development,
2800 Plymouth Road, Ann Arbor, MI 48105 (US). **PATT,**
William, Chester [US/US]; Pfizer Global Research & De-
velopment, 2800 Plymouth Road, Ann Arbor, MI 48105
(US).

(81) Designated States (national): AE, AG, AL, AM, AT, AU,
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,
CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,
MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG,
SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ,
VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM,
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR,
GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent
(BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR,
NE, SN, TD, TG).

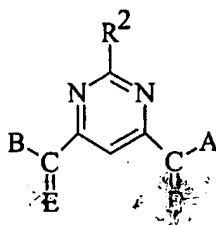
Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

WO 02/064571 A1

(54) Title: PYRIMIDINE MATRIX METALLOPROTEINASE INHIBITORS



(I)

(57) Abstract: Selective MMP-13 inhibitors are pyrimidine derivatives of the formula (I) or a pharmaceutically acceptable salt thereof, wherein R² is hydrogen, halo, hydroxy, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, NO₂, NR⁴ R⁵, CN, or CF₃; E is independently O or S; A and B independently are OR⁴ or NR⁴ R⁵; R⁴ and R⁵ independently are H, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, (CH₂)_n aryl, (CH₂)_n cycloalkyl, (CH₂)_n heteroaryl, or R⁴ and R⁵ when taken together with the nitrogen to which they are attached complete a 3- to 8-membered ring containing carbon atoms and optionally containing a heteroatom selected from O, S, or NH, and optionally substituted or unsubstituted; n is 0 to 6.

USSN 10/620,174 FILED: 07/15/2003
DOCKET NO. PC25036A

-1-

PYRIMIDINE MATRIX METALLOPROTEINASE INHIBITORS

FIELD OF THE INVENTION

This invention relates to pyrimidine derivatives which inhibit matrix metalloproteinase enzymes and thus are useful for treating diseases resulting from tissue breakdown such as heart disease, multiple sclerosis, osteo- and rheumatoid arthritis, atherosclerosis, and osteoporosis.

BACKGROUND OF THE INVENTION

Matrix metalloproteinases (sometimes referred to as MMPs) are naturally-occurring enzymes found in most mammals. Over-expression and activation of MMPs, or an imbalance between MMPs and inhibitors of MMPs, have been suggested as factors in the pathogenesis of diseases characterized by the breakdown of extracellular matrix or connective tissues.

Stromelysin-1 and gelatinase A are members of the MMP family. Other members include fibroblast collagenase (MMP-1), neutrophil collagenase (MMP-8), gelatinase B (92 kDa gelatinase) (MMP-9), stromelysin-2 (MMP-10), stromelysin-3 (MMP-11), matrilysin (MMP-7), collagenase 3 (MMP-13), TNF-alpha converting enzyme (TACE), and other newly discovered membrane-associated matrix metalloproteinases (Sato H., Takino T., Okada Y., Cao J., Shinagawa A., Yamamoto E., and Seiki M., *Nature*, 1994;370:61-65). These enzymes have been implicated with a number of diseases which result from breakdown of connective tissue, including such diseases as rheumatoid arthritis, osteoarthritis, osteoporosis, periodontitis, multiple sclerosis, gingivitis, corneal epidermal and gastric ulceration, atherosclerosis, neointimal proliferation which leads to restenosis and ischemic heart failure, and tumor metastasis. A method for preventing and treating these and other diseases is now recognized to be by inhibiting matrix metalloproteinase enzymes, thereby curtailing and/or eliminating the breakdown of connective tissues that results in the disease states.

-2-

There is a catalytic zinc domain in matrix metalloproteinases that is typically the focal point for inhibitor design. The modification of substrates by introducing zinc chelating groups has generated potent inhibitors such as peptide hydroxamates and thiol-containing peptides. Peptide hydroxamates and the natural
5 endogenous inhibitors of MMPs (TIMPs) have been used successfully to treat animal models of cancer and inflammation. MMP inhibitors have also been used to prevent and treat congestive heart failure and other cardiovascular diseases, United States Patent No. 5,948,780.

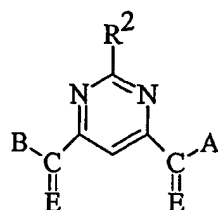
A major limitation on the use of currently known MMP inhibitors is their
10 lack of specificity for any particular enzyme. Recent data has established that specific MMP enzymes are associated with some diseases, with no effect on others. The MMPs are generally categorized based on their substrate specificity, and indeed the collagenase subfamily of MMP-1, MMP-8, and MMP-13 selectively cleave native interstitial collagens, and thus are associated only with
15 diseases linked to such interstitial collagen tissue. This is evidenced by the recent discovery that MMP-13 alone is overexpressed in breast carcinoma, while MMP-1 alone is overexpressed in papillary carcinoma (see Chen et al., *J. Am. Chem. Soc.*, 2000;122:9648-9654).

There appears to be few selective inhibitors of MMP-13 reported. A
20 compound named WAY-170523 has been reported by Chen et al., supra., 2000, and a few other compounds are reported in PCT International Application Publication Number WO 01/63244 A1, as allegedly selective inhibitors of MMP-13. Further, United States Patent Number 6,008,243 discloses inhibitors of MMP-13. However, no selective or nonselective inhibitor of MMP-13 has been
25 approved and marketed for the treatment of any disease in any mammal. Accordingly, the need continues to find new low molecular weight compounds that are potent and selective MMP inhibitors, and that have an acceptable therapeutic index of toxicity/potency to make them amenable for use clinically in the prevention and treatment of the associated disease states. An object of this
30 invention is to provide a group of selective MMP-13 inhibitor compounds characterized as being pyrimidine derivatives.

-3-

SUMMARY OF THE INVENTION

This invention provides a method for inhibiting matrix metalloproteinase enzymes, and especially MMP-13, using a pyrimidine or analog thereof. The invention is more particularly directed to a method for inhibiting MMP enzymes comprising administering to a host an MMP inhibiting amount of a compound defined by Formula I



I

or a pharmaceutically acceptable salt thereof,
wherein:

10 R² is hydrogen, halo, hydroxy, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₂-C₆ alkenyl,

C₂-C₆ alkynyl, NO₂, NR⁴R⁵, CN, or CF₃;

E is independently O or S;

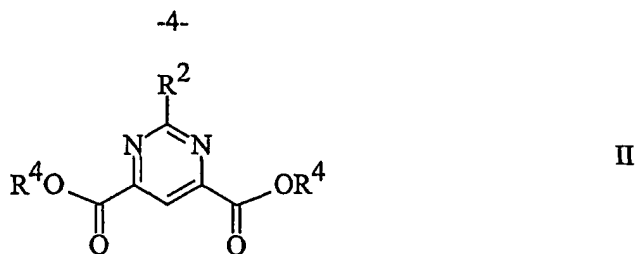
A and B independently are OR⁴ or NR⁵R⁶;

R⁴ and R⁵ independently are H, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl,

15 (CH₂)_n aryl, (CH₂)_n cycloalkyl, (CH₂)_n heteroaryl, or R⁴ and R⁵ when taken together with the nitrogen to which they are attached complete a 3- to 8-membered ring, containing carbon atoms and optionally containing a heteroatom selected from O, S, or NH, and optionally substituted or unsubstituted; and

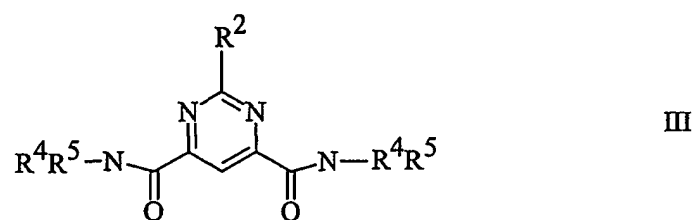
20 n is an integer from 0 to 6.

A preferred method of inhibiting MMP enzymes in a host comprises administering a compound of Formula II



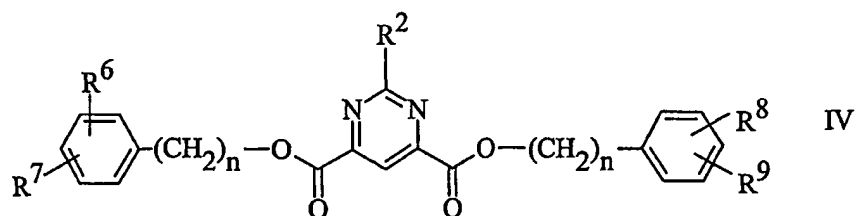
or a pharmaceutically acceptable salt thereof, wherein R^2 is as defined above, and each R^4 independently is as defined above.

Another preferred method for inhibiting MMP enzymes comprises
 5 administering a compound of Formula III



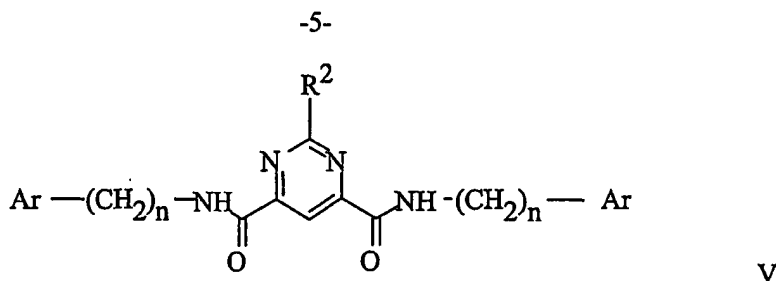
or a pharmaceutically acceptable salt thereof, wherein R^2 is as defined above, and each R^4 and R^5 independently are as defined above.

An especially preferred method comprises administering MMP inhibitors
 10 having Formula IV



or a pharmaceutically acceptable salt thereof, wherein n and R^2 are as defined above, and R^6 , R^7 , R^8 , and R^9 independently are hydrogen, halo, C_1 - C_6 alkyl, C_1 - C_6 alkoxy, nitro, or NH_2 .

Still another preferred method comprises administering an MMP inhibitor
 15 of Formula V



or a pharmaceutically acceptable salt thereof, wherein n and R² are as defined above, and each Ar independently is aryl or Het, wherein aryl is phenyl or substituted phenyl, and Het is an unsubstituted or substituted heteroaryl group.

5 Compounds of Formulas I, II, III, IV, and V are provided as a further embodiment of this invention. Preferred compounds are amides of Formula I wherein one or both of A and B is NR⁴R⁵, wherein R⁴ and R⁵ are as defined above. More preferred invention compounds are selected from:

10 Pyrimidine-4,6-dicarboxylic acid, (4-chloro-benzylamide), [(1,3-benzodioxol-5-ylmethyl)-amide];

 Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), [(1,3-benzodioxol-5-ylmethyl)-amide];

 Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (4-methoxy-benzylamide);

15 Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (3-methoxy-benzylamide);

 Pyrimidine-4,6-dicarboxylic acid, (4-carbomethoxy-benzylamide), (3-methoxy-benzylamide);

20 Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (3-pyridylmethylamide);

 Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (3-thiophenemethylamide);

 Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzothiadiazol-5-ylmethyl) amide, [(1,3-benzodioxol-5-ylmethyl)-amide];

25 Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzooxadiazol-5-ylmethyl) amide, [(1,3-benzodioxol-5-ylmethyl)-amide];

 Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzothiadiazol-5-ylmethyl) amide, (4-methoxy-benzylamide);

-6-

Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzothiadiazol-5-ylmethyl)
amide, (3-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid bis-(1,3-benzodioxol-5-ylmethyl) ester;

Pyrimidine-4,6-dicarboxylic acid, bis-(4-chloro-benzylamide);

5 Pyrimidine-4,6-dicarboxylic acid, bis-[(1,3-benzodioxol-5-ylmethyl)-
amide];

Pyrimidine-4,6-dicarboxylic acid, bis-(4-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, bis-(3-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, bis-(4-carboxy-benzylamide); and

10 Pyrimidine-4,6-dicarboxylic acid, bis-(4-carbomethoxy-benzylamide).

A further embodiment of this invention is a pharmaceutical composition,
comprising a compound of Formula I, or a pharmaceutically acceptable salt
thereof, admixed with a pharmaceutically acceptable carrier, excipient, or diluent.
A preferred composition comprises a compound of Formulas II, III, IV, or V, or a
15 pharmaceutically acceptable salt thereof. A more preferred composition comprises
a compound selected from:

Pyrimidine-4,6-dicarboxylic acid, (4-chloro-benzylamide), [(1,3-
benzodioxol-5-ylmethyl)-amide];

20 Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), [(1,3-
benzodioxol-5-ylmethyl)-amide];

Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (4-methoxy-
benzylamide);

Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (3-methoxy-
benzylamide);

25 Pyrimidine-4,6-dicarboxylic acid, (4-carbomethoxy-benzylamide),
(3-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide),
(3-pyridylmethylamide);

30 Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide),
(3-thiophenemethylamide);

Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzothiadiazol-5-ylmethyl)
amide, [(1,3-benzodioxol-5-ylmethyl)-amide];

-7-

Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzooxadiazol-5-ylmethyl)
amide, [(1,3-benzodioxol-5-ylmethyl)-amide];

Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzothiadiazol-5-ylmethyl)
amide, (4-methoxy-benzylamide);

5 Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzothiadiazol-5-ylmethyl)
amide, (3-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid bis-(1,3-benzodioxol-5-ylmethyl) ester;

Pyrimidine-4,6-dicarboxylic acid, bis-(4-chloro-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, bis-[(1,3-benzodioxol-5-ylmethyl)-
10 amide];

Pyrimidine-4,6-dicarboxylic acid, bis-(4-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, bis-(3-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, bis-(4-carboxy-benzylamide); and

Pyrimidine-4,6-dicarboxylic acid, bis-(4-carbomethoxy-benzylamide), or a
15 pharmaceutically acceptable salt thereof.

A further embodiment is a method for treating a disease mediated by an
MMP-13 enzyme, comprising administering to a patient suffering from such a
disease an effective amount of a compound of Formula I, or a pharmaceutically
acceptable salt thereof. A preferred method utilizes a compound of Formula I, or a
20 pharmaceutically acceptable salt thereof, wherein one or both of A and B is
NR⁴R⁵, wherein R⁴ and R⁵ are as defined above.

A further preferred method of treatment according to this invention is
treatment of a disease selected from cancer, (especially breast carcinoma),
inflammation, and heart failure comprising administering a compound of
Formula I, or a pharmaceutically acceptable salt thereof. Specific diseases to be
25 treated according to this invention include osteoarthritis and rheumatoid arthritis.

A further embodiment is use of a compound of Formula I, or a
pharmaceutically acceptable salt thereof, in the manufacture of a medicament for
the treatment of a disease mediated by an MMP-13 enzyme. Preferred is use of a
30 compound of Formula I, or a pharmaceutically acceptable salt thereof, wherein
one or both of A and B is NR⁴R⁵, wherein R⁴ and R⁵ are as defined above. Also

preferred is use of a compound of Formula II, III, IV, or V, or a pharmaceutically acceptable salt thereof.

DETAILED DESCRIPTION OF THE INVENTION

5 The compounds to be used in the method of inhibiting MMP enzymes provided by this invention are those defined by Formula I. In Formula I, R^1 to R^9 include "C₁-C₆ alkyl" groups. These are straight and branched carbon chains having from 1 to 6 carbon atoms. Examples of such alkyl groups include methyl, ethyl, isopropyl, tert-butyl, neopentyl, and n-hexyl. The alkyl groups can be
10 substituted if desired, for instance with groups such as hydroxy, amino, alkyl, and dialkylamino, halo, trifluoromethyl, carboxy, nitro, and cyano.

 "Alkenyl" means straight and branched hydrocarbon radicals having from 2 to 6 carbon atoms and one double bond and includes ethenyl, 3-buten-1-yl, 2-ethenylbutyl, 3-hexen-1-yl, and the like.

15 "Alkynyl" means straight and branched hydrocarbon radicals having from 2 to 6 carbon atoms and one triple bond and includes ethynyl, 3-butyn-1-yl, propynyl, 2-butyn-1-yl, 3-pentyn-1-yl, and the like.

 "Cycloalkyl" means a monocyclic or polycyclic hydrocarbyl group such as cyclopropyl, cycloheptyl, cyclooctyl, cyclodecyl, cyclobutyl, adamantyl,
20 norpinanyl, decalanyl, norbornyl, cyclohexyl, and cyclopentyl. Such groups can be substituted with groups such as hydroxy, keto, and the like. Also included are rings in which 1 to 3 heteroatoms replace carbons. Such groups are termed "heterocyclyl," which means a cycloalkyl group also bearing at least one heteroatom selected from O, S, or NR², examples being oxiranyl, pyrrolidinyl,
25 piperidyl, tetrahydropyran, and morpholine.

 "Alkoxy" refers to the alkyl groups mentioned above bound through oxygen, examples of which include methoxy, ethoxy, isopropoxy, tert-butoxy, and the like. In addition, alkoxy refers to polyethers such as -O-(CH₂)₂-O-OH₃, and the like.

“Acyl” means an R group that is an alkyl or aryl (Ar) group bonded through a carbonyl group, i.e., R-C(O)-, where R is alkyl or aryl. For example, acyl includes a C₁-C₆ alkanoyl, including substituted alkanoyl, wherein the alkyl portion can be substituted by NR⁴R⁵ or a carboxylic or heterocyclic group.

5 Typical acyl groups include acetyl, benzoyl, isonicotinoyl, and the like.

The alkyl, alkenyl, alkoxy, and alkynyl groups described above are optionally substituted, preferably by 1 to 3 groups selected from NR⁴R⁵, phenyl, substituted phenyl, thio C₁-C₆ alkyl, C₁-C₆ alkoxy, hydroxy, carboxy, C₁-C₆ alkoxycarbonyl, acyl, halo, nitrile, cycloalkyl, and a 5- or 6-membered carbocyclic ring or heterocyclic ring having 1 or 2 heteroatoms selected from nitrogen, substituted nitrogen, oxygen, and sulfur. “Substituted nitrogen” means nitrogen bearing C₁-C₆ alkyl or (CH₂)_nPh where n is 1, 2, or 3. Perhalo and polyhalo substitution is also embraced.

15 Examples of substituted alkyl groups include 2-aminoethyl, acetylmethyl, pentachloroethyl, trifluoromethyl, 2-diethylaminoethyl, 2-dimethylaminopropyl, ethoxycarbonylmethyl, 3-phenylbutyl, methanysulfanylmethyl, methoxymethyl, 3-hydroxypentyl, 2-carboxybutyl, 4-chlorobutyl, 3-cyclopropylpropyl, pentafluoroethyl, 3-morpholinopropyl, piperazinylmethyl, 4-benzoylbutyl, and 2-(4-methylpiperazinyl)ethyl.

20 Examples of substituted alkynyl groups include 2-methoxyethynyl, 2-benzoylethynyl, 2-ethylsulfanyethynyl, 4-(1-piperazinyl)-3-(butynyl), 3-phenyl-5-hexynyl, 3-diethylamino-3-butynyl, 4-chloro-3-butynyl, 4-cyclobutyl-4-hexenyl, and the like.

25 Typical substituted alkoxy groups include aminomethoxy, acetoxymethoxy, trifluoromethoxy, 2-diethylaminoethoxy, 2-ethoxycarbonylethoxy, 3-hydroxypropoxy, 6-carboxyhexyloxy, and the like.

Further, examples of substituted alkyl, alkenyl, and alkynyl groups include dimethylaminomethyl, carboxymethyl, 4-dimethylamino-3-buten-1-yl, 5-ethylmethylamino-3-pentyn-1-yl, 4-morpholinobutyl, 30 4-tetrahydropyridinylbutyl, 3-imidazolidin-1-ylpropyl, 4-tetrahydrothiazol-3-yl-butyl, phenylmethyl, 3-chlorophenylmethyl, and the like.

-10-

The terms "Ar" and "aryl" refer to unsubstituted and substituted aromatic groups. Heteroaryl (Het) groups have from 4 to 9 ring atoms, from 1 to 4 ring atoms of which are independently selected from the group consisting of O, S, and N. Preferred heteroaryl groups have 1 or 2 heteroatoms in a 5- or 6-membered aromatic ring. Mono- and bicyclic aromatic ring systems are included in the definition of aryl and heteroaryl. Preferred substituent groups include alkyl, alkoxy, halo, amino, alkylamino, dialkylamino, CN, CF₃, thioalkyl, acyl and hydroxy. Typical aryl and heteroaryl groups include phenyl, 3-chlorophenyl, 2,6-dibromophenyl, pyridyl, 3-methylpyridyl, benzothienyl, 2,4,6-tribromophenyl, 4-ethylbenzothienyl, furanyl, 3,4-diethylfuranyl, naphthyl, 4,7-dichloronaphthyl, morpholinyl, indolyl, benzotriazolyl, indazolyl, pyrrole, pyrazole, imidazole, thiazole, methylenedioxyphenyl, benzo-2,1,3-thiadiazole, benzo-2,1,3-oxadiazole, and the like.

Preferred Ar groups are phenyl and phenyl substituted by 1, 2, or 3 groups independently selected from the group consisting of alkyl, alkoxy, thio, thioalkyl, halo, hydroxy, -COOR⁷, trifluoromethyl, nitro, amino of the formula -NR⁴R⁵, and T(CH₂)_mQR⁴ or T(CH₂)_mCO₂R⁴ wherein m is 1 to 6, T is O, S, NR⁴, N(O)R⁴, NR⁴R⁶Y, or CR⁴R⁵, Q is O, S, NR⁵, N(O)R⁵, or NR⁵R⁶Y wherein R⁴ and R⁵ are as described above, and R⁷ is hydrogen, alkyl, or substituted alkyl, for example, methyl, trichloroethyl, diphenylmethyl, and the like. The alkyl and alkoxy groups can be substituted as defined above. For example, typical groups are carboxyalkyl, alkoxycarbonylalkyl, hydroxyalkyl, hydroxyalkoxy, and alkoxyalkyl. Typical substituted aryl groups include 2,6-dichlorophenyl, 3-hydroxyphenyl, 1,3-benzodioxolyl, 4-dimethylaminophenyl, 2,4,6-triethoxyphenyl, 3-cyanophenyl, 4-methylthiophenyl, and 3,5-dinitrophenyl.

Examples of NR⁴R⁵ groups include amino, methylamino, di-isopropylamino, acetyl amino, propionyl amino, 3-aminopropyl amino, 3-ethylaminobutyl amino, 3-di-n-propylamino-propyl amino, 4-diethylaminobutyl amino, and 3-carboxypropionyl amino. R⁴ and R⁵ can be taken together with the nitrogen to which they are attached to form a ring having 3 to 7 carbon atoms and 1, 2, or 3 heteroatoms selected from the group consisting of nitrogen, substituted

-11-

nitrogen, oxygen, and sulfur. Examples of such cyclic NR^4R^5 groups include pyrrolidinyl, piperazinyl, 4-methylpiperazinyl, 4-benzylpiperazinyl, pyridinyl, piperidinyl, pyrazinyl, morpholinyl, and the like.

"Halo" includes fluoro, chloro, bromo, and iodo.

5 The term "comprising", which is synonymous with the terms "including", "containing", or "characterized by", is inclusive or open-ended, and does not exclude additional, unrecited elements or method steps from the scope of the invention that is described following the term.

10 The phrase "consisting of", is closed-ended, and excludes any element, step, or ingredient not specified in the description of the invention that follows the phrase.

15 The phrase "consisting essentially of" limits the scope of the invention that follows to the specified elements, steps, or ingredients, and those further elements, steps, or ingredients that do not materially affect the basic and novel characteristics of the invention.

 The term "patient" means a mammal. Preferred patients include humans, cats, dogs, cows, horses, pigs, and sheep.

20 The term "animal" means a mammal. Preferred animals are include humans, rats, mice, guinea pigs, rabbits, monkeys, cats, dogs, cows, horses, pigs, and sheep.

25 The phrases "therapeutically effective amount" and "effective amount" are synonymous unless otherwise indicated, and mean an amount of a compound of the present invention that is sufficient to improve the condition, disease, or disorder being treated. Determination of a therapeutically effective amount, as well as other factors related to effective administration of a compound of the present invention to a patient in need of treatment, including dosage forms, routes of administration, and frequency of dosing, may depend upon the particulars of the condition that is encountered, including the patient and condition being treated, the severity of the condition in a particular patient, the particular compound being employed, the particular route of administration being employed, 30 the frequency of dosing, and the particular formulation being employed. Determination of a therapeutically effective treatment regimen for a patient is

-12-

within the level of ordinary skill in the medical or veterinarian arts. In clinical use, an effective amount may be the amount that is recommended by the U.S. Food and Drug Administration, or an equivalent foreign agency.

5 The phrase "admixed" or "in admixture" means the ingredients so mixed comprise either a heterogeneous or homogeneous mixture. Preferred is a homogeneous mixture.

10 The phrases "pharmaceutical preparation" and "preparation" are synonymous unless otherwise indicated, and include the formulation of the active compound with encapsulating material as a carrier providing a capsule in which the active component, with or without other carriers, is surrounded by a carrier, which is thus in association with it. Similarly, cachets and lozenges are included. Pharmaceutical preparations are fully described below.

15 The phrase "anticancer effective amount" means an amount of invention compound, or a pharmaceutically acceptable salt thereof, sufficient to inhibit, halt, or cause regression of the cancer being treated in a particular patient or patient population. For example in humans or other mammals, an anticancer effective amount can be determined experimentally in a laboratory or clinical setting, or may be the amount required by the guidelines of the United States Food and Drug Administration, or equivalent foreign agency, for the particular cancer and patient being treated.

20 The phrase "MMP-13 inhibiting amount" means an amount of invention compound, or a pharmaceutically acceptable salt thereof, sufficient to inhibit an enzyme matrix metalloproteinase-13, including a truncated form thereof, including a catalytic domain thereof, in a particular animal or animal population. For example in a human or other mammal, an MMP-13 inhibiting amount can be determined experimentally in a laboratory or clinical setting, or may be the amount required by the guidelines of the United States Food and Drug Administration, or equivalent foreign agency, for the particular MMP-13 enzyme and patient being treated.

30 It should be appreciated that the matrix metalloproteinases include the following enzymes:

-13-

MMP-1, also known as interstitial collagenase, collagenase-1, or fibroblast-type collagenase;

MMP-2, also known as gelatinase A or 72 kDa Type IV collagenase;

MMP-3, also known as stromelysin or stromelysin-1;

5 MMP-7, also known as matrilysin or PUMP-1;

MMP-8, also known as collagenase-2, neutrophil collagenase, or polymorphonuclear-type ("PMN-type") collagenase;

MMP-9, also known as gelatinase B or 92 kDa Type IV collagenase;

MMP-10, also known as stromelysin-2;

10 MMP-11, also known as stromelysin-3;

MMP-12, also known as metalloelastase;

MMP-13, also known as collagenase-3;

MMP-14, also known as membrane-type ("MT") 1-MMP or MT1-MMP;

MMP-15, also known as MT2-MMP;

15 MMP-16, also known as MT3-MMP;

MMP-17, also known as MT4-MMP;

MMP-18; and

MMP-19.

20 Other MMPs are known, including MMP-26, which is also known as matrilysin-2.

One aspect of the present invention is compounds of Formula I, or a pharmaceutically acceptable salt thereof, that are selective inhibitors of the enzyme MMP-13. A selective inhibitor of MMP-13, as used in the present invention, is a compound that is ≥ 5 times more potent *in vitro* versus MMP-
25 13 than versus at least one other matrix metalloproteinase enzyme such as, for example, MMP-1, MMP-2, MMP-3, MMP-7, MMP-8, MMP-9, or MMP-14, or versus tumor necrosis factor alpha convertase ("TACE"). A preferred aspect of the present invention is compounds that are selective inhibitors of MMP-13 versus MMP-1.

30 Still other aspects of the present invention are compounds of Formula I, or a pharmaceutically acceptable salt thereof, that are selective inhibitors of MMP-13 versus 2, 3, 4, 5, 6, or 7 other MMP enzymes, or versus TACE and 1, 2, 3, 4, 5, 6, or 7 other MMP enzymes. Other aspects of the present invention are compounds

-14-

of Formula I, or a pharmaceutically acceptable salt thereof, that are ≥ 10 times, ≥ 20 times, ≥ 50 times, ≥ 100 times, or ≥ 1000 times more potent versus MMP-13 than versus at least one of any other MMP enzyme or TACE.

5 It should be appreciated that determination of proper dosage forms, dosage amounts, and routes of administration, is within the level of ordinary skill in the pharmaceutical and medical arts, and is described below.

The term "IC₅₀" means the concentration of test compound required to inhibit activity of a biological target, such as a receptor or enzyme, by 50%.

10 The phrase "catalytic domain" means the domain containing a catalytic zinc cation of the MMP enzyme, wherein the MMP enzyme contains 2 or more domains. A catalytic domain includes truncated forms thereof that retain at least some of the catalytic activity of MMP-13 or MMP-13CD. For example, the collagenases, of which MMP-13 is a member, have been reported to contain a signal peptide domain, a propeptide domain, a catalytic domain, and a hemopexin-
15 like domain (Ye Qi-Zhuang, Hupe D., Johnson L., *Current Medicinal Chemistry*, 1996;3:407-418).

The phrase "a method for inhibiting MMP-13" includes methods of inhibiting full length MMP-13, truncated forms thereof that retain catalytic activity, including forms that contain the catalytic domain of MMP-13, as well as
20 the catalytic domain of MMP-13 alone, and truncated forms of the catalytic domain of MMP-13 that retain at least some catalytic activity.

It should be appreciated that it has been shown previously (Ye Qi-Zhuang, et al., 1996, supra) that inhibitor activity against a catalytic domain of an MMP is predictive of the inhibitor activity against the respective full-length enzyme.

25 The compounds to be used in the present invention can exist in unsolvated forms as well as solvated forms, including hydrated forms. In general, the solvated forms, including hydrated forms, are equivalent to unsolvated forms and are intended to be encompassed within the scope of the present invention.

30 The compounds of Formula I may have chiral centers, and thus can exist as racemic mixtures and individual enantiomers. All such isomeric forms can be used in the method of this invention and are provided as new compounds.

-15-

The compounds of Formula I are capable of further forming both pharmaceutically acceptable formulations comprising salts, including but not limited to acid addition and/or base salts, solvents and N-oxides of a compound of Formula I. This invention also provides pharmaceutical formulations comprising a compound of Formula I together with a pharmaceutically acceptable carrier, diluent, or excipient therefor. All of these forms can be used in the method of the present invention.

Pharmaceutically acceptable acid addition salts of the compounds of Formula I include salts derived from inorganic acids such as hydrochloric, nitric, phosphoric, sulfuric, hydrobromic, hydriodic, phosphorus, and the like, as well as the salts derived from organic acids, such as aliphatic mono- and dicarboxylic acids, phenyl-substituted alkanolic acids, hydroxy alkanolic acids, alkanedioic acids, aromatic acids, aliphatic and aromatic sulfonic acids, etc. Such salts thus include sulfate, pyrosulfate, bisulfate, sulfite, bisulfite, nitrate, phosphate, monohydrogenphosphate, dihydrogenphosphate, metaphosphate, pyrophosphate, chloride, bromide, iodide, acetate, propionate, caprylate, isobutyrate, oxalate, malonate, succinate, suberate, sebacate, fumarate, maleate, mandelate, benzoate, chlorobenzoate, methylbenzoate, dinitrobenzoate, phthalate, benzenesulfonate, toluenesulfonate, phenylacetate, citrate, lactate, maleate, tartrate, methanesulfonate, and the like. Also contemplated are the salts of amino acids such as arginate, gluconate, galacturonate, and the like; see, for example, Berge et al., "Pharmaceutical Salts," *J. of Pharmaceutical Science*, 1977;66:1-19.

The acid addition salts of the basic compounds are prepared by contacting the free base form with a sufficient amount of the desired acid to produce the salt in the conventional manner. The free base form may be regenerated by contacting the salt form with a base and isolating the free base in the conventional manner. The free base forms differ from their respective salt forms somewhat in certain physical properties such as solubility in polar solvents, but otherwise the salts are equivalent to their respective free base for purposes of the present invention.

Pharmaceutically acceptable base addition salts are formed with metals or amines, such as alkali and alkaline earth metal hydroxides, or of organic amines. Examples of metals used as cations are sodium, potassium, magnesium, calcium,

-16-

and the like. Examples of suitable amines are N,N'-dibenzylethylenediamine, chloroprocaine, choline, diethanolamine, ethylenediamine, N-methylglucamine, and procaine; see, for example, Berge et al., supra., 1977.

5 The base addition salts of acidic compounds are prepared by contacting the free acid form with a sufficient amount of the desired base to produce the salt in the conventional manner. The free acid form may be regenerated by contacting the salt form with an acid and isolating the free acid in a conventional manner. The free acid forms differ from their respective salt forms somewhat in certain physical properties such as solubility in polar solvents, but otherwise the salts are
10 equivalent to their respective free acid for purposes of the present invention.

The compounds of the present invention can be formulated and administered in a wide variety of oral and parenteral dosage forms, including transdermal and rectal administration. All that is required is that an MMP inhibitor be administered to a mammal suffering from a disease in an effective amount,
15 which is that amount required to cause an improvement in the disease and/or the symptoms associated with such disease. It will be recognized to those skilled in the art that the following dosage forms may comprise as the active component, either a compound of Formula I or a corresponding pharmaceutically acceptable salt or solvate of a compound of Formula I.

20 The invention compounds are prepared by methods well known to those skilled in the art of organic chemistry. The compounds of Formula I are prepared utilizing commercially available starting materials, or reactants that are readily prepared by standard organic synthetic techniques. A typical synthesis of the invention compounds of Formula I is shown in Scheme 1 below. The first step in
25 Scheme 1 comprises reacting a diacid with a chlorinating reagent such as thionyl chloride or oxalyl chloride in a nonprotic solvent such as dichloromethane (DCM) to give the diacid chloride. This acid chloride can then be reacted with an amine, NHR^4R^5 , in excess or with an organic base such as triethylamine, to give a bis-amide of Formula I. Alternately, the acid chloride can be reacted with an alcohol,
30 R^4OH , in a nonprotic solvent such as dichloromethane along with an organic or inorganic base such as triethylamine or potassium carbonate to give a bis-ester of Formula I. The bis-ester can in some circumstances be reacted with an amine,

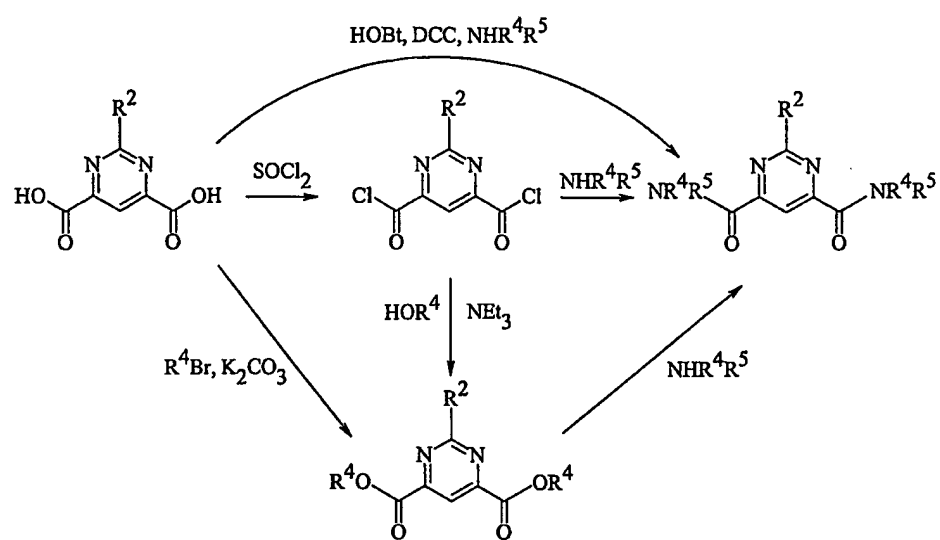
-17-

NHR⁴R⁵, at elevated temperatures to give a bis-amide of Formula I. The diacid can also be reacted with an alkyl halide in a nonprotic solvent containing an organic or inorganic base to give a bis-ester of Formula I. A third sequence involves the reaction of the diacid with hydroxybenzotriazole, HOBt, and
5 dicyclohexylcarbodiimide, DCC, and an amine, NHR⁴R⁵, in a solvent such as dimethylformamide, DMF, or dichloromethane to give a bis-amide of Formula I.

Compounds of Formula I have also been synthesized using combinatorial techniques, Scheme 2. The diacid chloride is bound to a resin such as Marshall resin to give a bound acid chloride. The bound acid chloride is then reacted with
10 an amine, NHR⁴R⁵, in the presence of triethylamine in a solvent such as DCM to give a resin-bound amide. The resin is then cleaved by reaction with an amine, NHR⁴R⁵, in dioxane in the presence of an organic base to give a bis-amide of Formula I, wherein each R⁴ and R⁵ independently are as defined above.

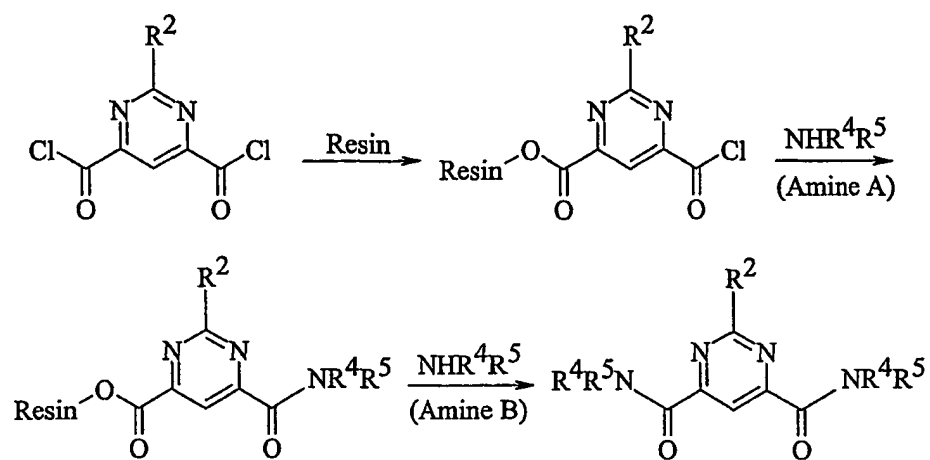
-18-

Scheme 1



-19-

Scheme 2



-20-

The following detailed examples further illustrate the synthesis of typical invention compounds of Formula I. The examples are representative only, and are not to be construed as limiting the invention in any respect.

EXAMPLE 1

5 **Pyrimidine-4,6-dicarboxylic acid, bis-benzylamide**

Pyrimidine-4,6-dicarboxylic acid is dissolved in dichloromethane (DCM) at 24°C. To the solution is added three equivalents of thionyl chloride. The reaction mixture is stirred at 24°C for 1 hour. The reaction mixture is concentrated by evaporation of the solvent under reduced pressure to give an oil. The oil is
10 dissolved in ethyl acetate, and three equivalents of benzylamine are added. The reaction mixture is stirred at 24°C for 3 hours. The solvent is then removed by evaporation under reduced pressure to give an oil. The oil is purified by chromatography over silica gel, eluting with hexane-ethyl acetate (9:1) to 100% ethyl acetate. The fractions shown by thin layer chromatography to contain a
15 single product component are combined and concentrated to dryness under reduced pressure to give the title compound.

EXAMPLE 2

Combinatorial synthesis method

Loading of the resin is carried out as follows:

20 Marshall resin (15.2 g, 21.25 mmol) is swollen in DCM (300 mL) in a 500-mL resin tube (CAUTION: Slightly exothermic, the DCM may boil), and the mixture is allowed to cool. Once the mixture is cooled, the tube is capped and agitated slowly for 5 minutes, venting frequently. The DCM is drained to waste. The DCM wash is repeated two additional times, then the resin is resuspended in
25 DCM (300 mL), and triethylamine (TEA, 3.2 g, 32 mmol, 1.5 mol. eq.) is added slowly. The resulting mixture is swirled for 5 minutes, and pyrimidine-4,6-dicarboxylic acid dichloride (17.2 g, 85 mmol, 4 eq) is added in one portion. The resin tube is capped, carefully secured in a wrist shaker, and inverted for 36 hours.

30 After 36 hours, a slight darkening of the resin may be noted. The reaction solvent is drained, and the residual resin is washed three times with DCM

-21-

(200 mL) and two times with diethyl ether (200 mL). The resin is dried in vacuo for 24 hours. Resin loading is determined both by weight gain and by total chloride determination. Typical loading is about 1.1 mmol/g.

Resin distribution is performed as follows:

5 A Miniblock resin loader is calibrated for each resin used in the protocol. The weight in milligrams of resin added per well is recorded, and the number of millimoles per well of bound pyrimidine-4,6-dicarboxylic acid chloride is calculated. Using this calibration and the loading for each resin, 0.15 mmol of resin is distributed into each reaction tube. The valve on the block is closed.

10 **Amine solution prep:**

 An "A" amine set (NHR^4R^5) is diluted to 0.5 M in DCM. A 0.2 M solution of TEA in DCM (1.5 mL per reaction) is prepared. A 0.2 M solution of TEA in dioxane (1.5 mL per reaction) is prepared. A "B" amine set (NHR^4R^5) is diluted to 0.5 M in dioxane.

15 **Addition of amine A:**

 The TEA solution in DCM from above (1.5 mL) is added to each reaction tube, then using the Miniblock Map as a guide, the appropriate "A" amine (315 μL , 1.05 eq) is distributed. The mixtures are shaken for 24 hours. After 24 hours, the reaction block is placed on a filtration station without a collection block, and the reactions are drained to waste. The valve is closed, and 2 mL of DCM is added. The mixtures are shaken for 2 minutes, and the reactions are drained to waste again. Unless the following step is to be carried out immediately, the reaction blocks are preferably stored under vacuum.

Addition of amine B/resin cleavage:

25 The TEA solution in dioxane from above (1.5 mL) is added to each reaction tube, then using the Miniblock Map as a guide, the appropriate "B" amine (300 μL , 1.05 eq) is distributed. The mixture is shaken for 72 hours. After 72 hours, the reaction block is placed on a filtration station with a labeled collection block, and the reactions are drained. The valve is closed, 2 mL of DCM is added, and the mixture is shaken for 2 minutes. The reactions are drained into the collection tubes.

-22-

Analysis:

The products in the tubes may be identified by loop mass spectrometry after first evaporating the DCM from the MS samples.

Concentrate:

5 The samples are concentrated in a Genevac.

 The invention compounds of Formula I can be evaluated in standard assays for their ability to inhibit the activity of various MMP enzymes. The assays that can be used to evaluate the biological activity of the invention compounds are well-known and routinely used by those skilled in the study of MMP inhibitors
10 and their use to treat clinical conditions. The assays measure the amount by which a test compound reduces the hydrolysis of a thiopeptolide substrate catalyzed by a matrix metalloproteinase enzyme. Such assays are described in detail by Ye et al., in *Biochemistry*, 1992;31(45):11231-11235, which is incorporated herein by reference.

15 Thiopeptolide substrates show virtually no decomposition or hydrolysis in the absence of a matrix metalloproteinase enzyme. A typical thiopeptolide substrate commonly utilized for assays is Ac-Pro-Leu-Gly-thioester-Leu-Leu-Gly-OEt. A 100- μ L assay mixture will contain 50 mM of N-2-hydroxyethylpiperazine-N'-2-ethanesulfonic acid buffer ("HEPES") at pH 7.0, 10 mM CaCl_2 , 100 μ M
20 thiopeptolide substrate, and 1 mM 5,5'-dithio-bis-(2-nitro-benzoic acid) (DTNB). The thiopeptolide substrate concentration can be varied, for example from 10 to 800 μ M, to obtain K_m and K_{cat} values. The change in absorbance at 405 nm is monitored on a Thermo Max microplate reader (Molecular Devices, Menlo Park, CA) at room temperature (22°C). The calculation of the amount of hydrolysis of
25 the thiopeptolide substrate is based on $E_{412} = 13600 \text{ M}^{-1} \text{ cm}^{-1}$ for the DTNB-derived product 3-carboxy-4-nitrothiophenoxide. Assays can be carried out with and without matrix metalloproteinase inhibitor compounds, and the amount of hydrolysis can be compared for a determination of inhibitory activity of the test compounds.

30 It should be appreciated that the assay buffer that can be used with stromelysin-1 catalytic domain ("MMP-3CD") is 50 mM of N-morpholinoethane

-23-

sulfonic acid monohydrate ("MES") at pH 6.0 rather than the HEPES buffer at pH 7.0 described above.

Compounds of Formula I, or a pharmaceutically acceptable salt thereof, are expected to inhibit MMP-13, including MMP-13CD, with IC_{50} 's typically in the range of from about 0.001 micromolar to about 10 micromolar, while the compounds are expected to inhibit full length MMP-1, full length MMP-2, MMP-3CD, full length MMP-7, full length MMP-9, MMP-12 catalytic domain, and MMP-14 catalytic domain with IC_{50} 's in the range of from about 20 micromolar to greater than 100 micromolar.

The invention compounds of Formula I promise to be potent inhibitors of MMP enzymes and will be especially useful due to their expected selective inhibition of MMP-13. Because of their expected potent and selective inhibitory activity, the invention compounds will be especially useful to treat diseases mediated by the MMP enzymes, and particularly those mediated by MMP-13.

Administration of an invention compound of Formula I, or a pharmaceutically acceptable salt thereof, to a mammal to treat the diseases mediated by MMP enzymes is preferably, although not necessarily, accomplished by administering the compound, or the salt thereof, in a pharmaceutical dosage form.

The compounds of the present invention can be prepared and administered in a wide variety of oral and parenteral dosage forms. Thus, the compounds of the present invention can be administered by injection, that is, intravenously, intramuscularly, intracutaneously, subcutaneously, intraduodenally, or intraperitoneally. Also, the compounds of the present invention can be administered by inhalation, for example, intranasally. Additionally, the compounds of the present invention can be administered transdermally. It will be obvious to those skilled in the art that the following dosage forms may comprise as the active component, either a compound of Formula I or a corresponding pharmaceutically acceptable salt of a compound of Formula I. The active compound generally is present in a concentration of about 5% to about 95% by weight of the formulation.

For preparing pharmaceutical compositions from the compounds of the present invention, pharmaceutically acceptable carriers can be either solid or

-24-

liquid. Solid form preparations include powders, tablets, pills, capsules, cachets, suppositories, and dispersible granules. A solid carrier can be one or more substances which may also act as diluents, flavoring agents, solubilizers, lubricants, suspending agents, binders, preservatives, tablet disintegrating agents, or an encapsulating material.

In powders, the carrier is a finely divided solid which is in a mixture with the finely divided active component.

In tablets, the active component is mixed with the carrier having the necessary binding properties in suitable proportions and compacted in the shape and size desired.

The powders and tablets preferably contain from 5% or 10% to about 70% of the active compound. Suitable carriers are magnesium carbonate, magnesium stearate, talc, sugar, lactose, pectin, dextrin, starch, gelatin, tragacanth, methylcellulose, sodium carboxymethylcellulose, a low melting wax, cocoa butter, and the like. The term "preparation" is intended to include the formulation of the active compound with encapsulating material as a carrier providing a capsule in which the active component, with or without other carriers, is surrounded by a carrier, which is thus in association with it. Similarly, cachets and lozenges are included. Tablets, powders, capsules, pills, cachets, and lozenges can be used as solid dosage forms suitable for oral administration.

For preparing suppositories, a low melting wax, such as a mixture of fatty acid glycerides or cocoa butter, is first melted and the active component is dispersed homogeneously therein, as by stirring. The molten homogeneous mixture is then poured into convenient sized molds, allowed to cool, and thereby to solidify.

Liquid form preparations include solutions, suspensions, and emulsions, for example, water or water propylene glycol solutions. For parenteral injection, liquid preparations can be formulated in solution in aqueous polyethylene glycol solution.

Aqueous solutions suitable for oral use can be prepared by dissolving the active component in water and adding suitable colorants, flavors, stabilizing, and thickening agents as desired.

-25-

Aqueous suspensions suitable for oral use can be made by dispersing the finely divided active component in water with viscous material, such as natural or synthetic gums, resins, methylcellulose, sodium carboxymethylcellulose, and other well-known suspending agents.

5 Also included are solid form preparations which are intended to be converted, shortly before use, to liquid form preparations for oral administration. Such liquid forms include solutions, suspensions, and emulsions. These preparations may contain, in addition to the active component, colorants, flavors, stabilizers, buffers, artificial and natural sweeteners, dispersants, thickeners, 10 solubilizing agents, and the like.

 The pharmaceutical preparation is preferably in unit dosage form. In such form, the preparation is subdivided into unit doses containing appropriate quantities of the active component. The unit dosage form can be a packaged preparation, the package containing discrete quantities of preparation, such as 15 packeted tablets, capsules, and powders in vials or ampoules. Also, the unit dosage form can be a capsule, tablet, cachet, or lozenge itself, or it can be the appropriate number of any of these in packaged form.

 The quantity of active component in a unit dose preparation may be varied or adjusted from 1 to 1000 mg, preferably 10 to 100 mg according to the particular 20 application and the potency of the active component. The composition can, if desired, also contain other compatible therapeutic agents.

 In therapeutic use as agents to inhibit a matrix metalloproteinase enzyme for the treatment of atherosclerotic plaque rupture, aortic aneurism, heart failure, restenosis, periodontal disease, corneal ulceration, cancer metastasis, tumor 25 angiogenesis, arthritis, or other autoimmune or inflammatory disorders dependent upon breakdown of connective tissue, the compounds utilized in the pharmaceutical method of this invention are administered at a dose that is effective to inhibit the hydrolytic activity of one or more matrix metalloproteinase enzymes. The initial dosage of about 1 mg/kg to about 100 mg/kg daily will be 30 effective. A daily dose range of about 25 mg/kg to about 75 mg/kg is preferred. The dosages, however, may be varied depending upon the requirements of the patient, the severity of the condition being treated, and the compound being employed. Determination of the proper dosage for a particular situation is within

-26-

the skill of the art. Generally, treatment is initiated with smaller dosages which are less than the optimum dose of the compound. Thereafter, the dosage is increased by small increments until the optimum effect under the circumstance is reached. For convenience, the total daily dosage may be divided and administered in portions during the day if desired. Typical dosages will be from about 0.1 mg/kg to about 500 mg/kg, and ideally about 25 mg/kg to about 250 mg/kg, such that it will be an amount which is effective to treat the particular disease being prevented or controlled.

The following examples illustrate typical pharmaceutical compositions provided by the invention.

Composition Example 1

Tablet Formulation

Ingredient	Amount (mg/tablet)
Compound of Example 1	25
Lactose	50
Cornstarch (for mix)	10
Cornstarch (paste)	10
Magnesium stearate (1%)	5
Total	100

The compound of Example 1, lactose, and cornstarch (for mix) are blended to uniformity. The cornstarch (for paste) is suspended in 200 mL of water and heated with stirring to form a paste. The paste is used to granulate the mixed powders. The wet granules are passed through a No. 8 hand screen and dried at 80°C. The dry granules are lubricated with the 1% magnesium stearate and pressed into a tablet. Such tablets can be administered to a human from one to four times a day for treatment of atherosclerosis and arthritis.

-27-

Composition Example 2

Preparation for Oral Solution

Ingredient	Amount
Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), [(1,3-benzodioxol-5-ylmethyl)-amide]	400 mg
Sorbitol solution (70% N.F.)	40 mL
Sodium benzoate	20 mg
Saccharin	5 mg
Red dye	10 mg
Cherry flavor	20 mg
Distilled water q.s.	100 mL

The sorbitol solution is added to 40 mL of distilled water, and the invention compound named pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), [(1,3-benzodioxol-5-ylmethyl)-amide] is dissolved therein. The saccharin, sodium benzoate, flavor, and dye are added and dissolved. The volume is adjusted to 100 mL with distilled water. Each milliliter of syrup contains 4 mg of invention compound.

Composition Example 3

10 Parenteral Solution

In a solution of 700 mL of propylene glycol and 200 mL of water for injection is suspended 20 g of the invention compound named pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (4-methoxy-benzylamide). After suspension is complete, the pH is adjusted to 6.5 with 1N sodium hydroxide, and the volume is made up to 1000 mL with water for injection. The formulation is sterilized, filled into 5.0-mL ampoules each containing 2.0 mL, and sealed under nitrogen.

As matrix metalloproteinase inhibitors, the compounds of Formula I are useful as agents for the treatment of multiple sclerosis. They are also useful as agents for the treatment of atherosclerotic plaque rupture, restenosis, periodontal

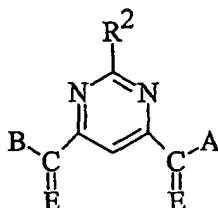
-28-

disease, corneal ulceration, treatment of burns, decubital ulcers, wound repair, heart failure, cancer metastasis, tumor angiogenesis, arthritis, and other inflammatory disorders dependent upon tissue invasion by leukocytes.

CLAIMS

What is claimed is:

1. A method for inhibiting matrix metalloproteinase enzymes in a mammal comprising administering an MMP inhibiting amount of a compound of Formula I



I

or a pharmaceutically acceptable salt thereof,

wherein:

R^2 is hydrogen, halo, hydroxy, C_1 - C_6 alkyl, C_1 - C_6 alkoxy, C_2 - C_6

alkenyl, C_2 - C_6 alkynyl, NO_2 , NR^4R^5 , CN, or CF_3 ;

E is independently O or S;

A and B independently are OR^4 or NR^4R^5 ;

R^4 and R^5 independently are H, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6

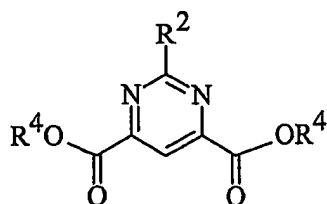
alkynyl, $(CH_2)_n$ aryl, $(CH_2)_n$ cycloalkyl, $(CH_2)_n$ heteroaryl, or R^4

and R^5 when taken together with the nitrogen to which they are attached complete a 3- to 8-membered ring, containing carbon atoms and optionally containing a heteroatom selected from O, S, or NH, and optionally substituted or unsubstituted;

n is an integer from 0 to 6.

2. A method for inhibiting matrix metalloproteinase enzymes in a mammal comprising administering an MMP inhibiting amount of a compound of Formula II

-30-



II

or a pharmaceutically acceptable salt thereof,

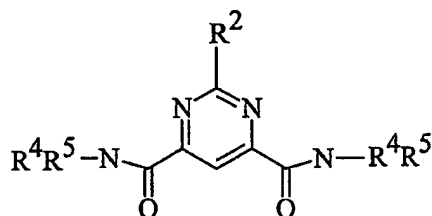
wherein R^2 is hydrogen, halo, hydroxy, C_1 - C_6 alkyl, C_1 - C_6 alkoxy,

C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, NO_2 , NR^4R^5 , CN, or CF_3 ; and

5 each R^4 is independently H, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl,

$(CH_2)_n$ aryl, $(CH_2)_n$ cycloalkyl, $(CH_2)_n$ heteroaryl; or

A method for inhibiting matrix metalloproteinase enzymes in a mammal comprising administering an MMP inhibiting amount of a compound of Formula III



III

or a pharmaceutically acceptable salt thereof,

wherein R^2 is hydrogen, halo, hydroxy, C_1 - C_6 alkyl, C_1 - C_6 alkoxy,

C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, NO_2 , NR^4R^5 , CN, or CF_3 ;

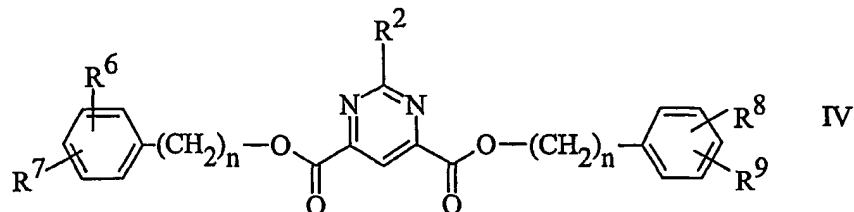
R^4 and R^5 independently are H, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6

15 alkynyl, $(CH_2)_n$ aryl, $(CH_2)_n$ cycloalkyl, $(CH_2)_n$ heteroaryl, or R^4

and R^5 when taken together with the nitrogen to which they are attached complete a 3- to 8-membered ring containing carbon atoms and optionally containing a heteroatom selected from O, S, or NH, and optionally substituted or unsubstituted; or

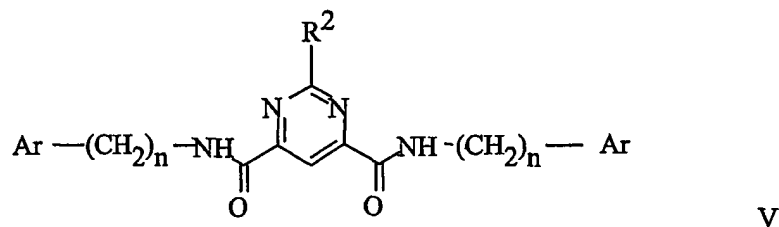
-31-

A method for inhibiting matrix metalloproteinase enzymes in a mammal comprising administering an MMP inhibiting amount of a compound of Formula IV



- 5 or a pharmaceutically acceptable salt thereof,
 wherein n is 0 to 6;
 R² is hydrogen, halo, hydroxy, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₂-C₆
 alkenyl, C₂-C₆ alkynyl, NO₂, NR⁴R⁵, CN, or CF₃; and R⁶, R⁷, R⁸, and
 R⁹ independently are hydrogen, halo, C₁-C₆ alkyl, C₁-C₆ alkoxy, nitro, or
 10 NH₂; or

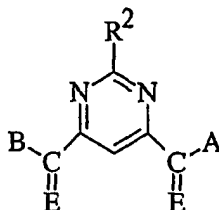
A method for inhibiting matrix metalloproteinase enzymes in a mammal comprising administering an MMP inhibiting amount of a compound of Formula V



- 15 or a pharmaceutically acceptable salt thereof,
 wherein n is 0 to 6;
 R² is hydrogen, halo, hydroxy, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₂-C₆
 alkenyl, C₂-C₆ alkynyl, NO₂, NR⁴R⁵, CN, or CF₃;
 Each Ar independently is aryl or Het;
 20 Aryl is phenyl or substituted phenyl;
 Het is an unsubstituted or substituted heteroaryl group.

-32-

3. A compound having Formula I



I

or a pharmaceutically acceptable salt thereof,

wherein:

5 R^2 is hydrogen, halo, hydroxy, C_1 - C_6 alkyl, C_1 - C_6 alkoxy, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, NO_2 , NR^4R^5 , CN, or CF_3 ;

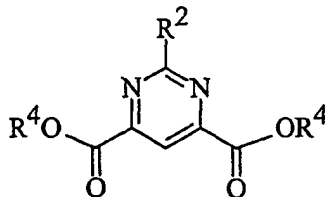
E is independently O or S;

A and B independently are OR^4 or NR^4R^5 ;

10 R^4 and R^5 independently are H, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, $(CH_2)_n$ aryl, $(CH_2)_n$ cycloalkyl, $(CH_2)_n$ heteroaryl, or R^4 and R^5 when taken together with the nitrogen to which they are attached complete a 3- to 8-membered ring containing carbon atoms and optionally containing a heteroatom selected from O, S, or NH, and optionally substituted or unsubstituted;

15 n is an integer from 0 to 6; or

A compound of Formula II



II

or a pharmaceutically acceptable salt thereof,

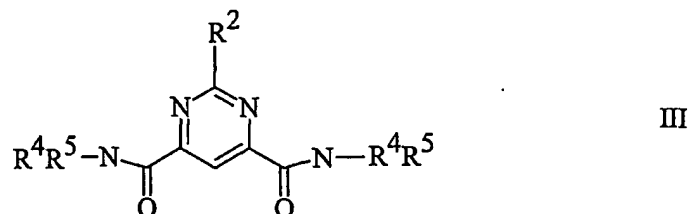
wherein R^2 is hydrogen, halo, hydroxy, C_1 - C_6 alkyl, C_1 - C_6 alkoxy,

20 C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, NO_2 , NR^4R^5 , CN, or CF_3 ; and

each R^4 is independently H, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, $(CH_2)_n$ aryl, $(CH_2)_n$ cycloalkyl, $(CH_2)_n$ heteroaryl; or

-33-

A compound of Formula III



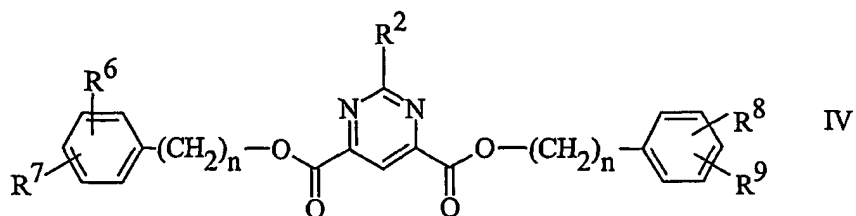
or a pharmaceutically acceptable salt thereof,

wherein R^2 is hydrogen, halo, hydroxy, C_1 - C_6 alkyl, C_1 - C_6 alkoxy,5 C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, NO_2 , NR^4R^5 , CN, or CF_3 ; R^4 and R^5 independently are H, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, $(CH_2)_n$ aryl, $(CH_2)_n$ cycloalkyl, $(CH_2)_n$ heteroaryl, or R^4 and R^5 when taken together with the nitrogen to which they are

attached complete a 3- to 8-membered ring containing carbon

10 atoms and optionally containing a heteroatom selected from O, S, or NH, and optionally substituted or unsubstituted; or

A compound of Formula IV



or a pharmaceutically acceptable salt thereof,

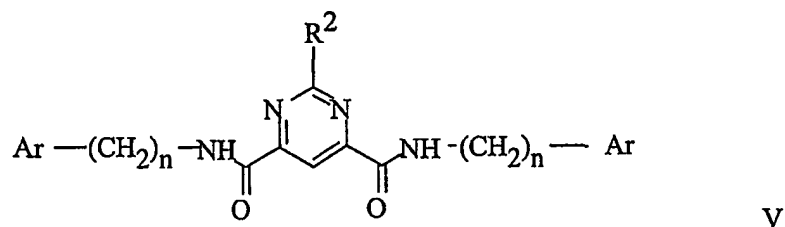
15 wherein n is 0 to 6;

 R^2 is hydrogen, halo, hydroxy, C_1 - C_6 alkyl, C_1 - C_6 alkoxy, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, NO_2 , NR^4R^5 , CN, or CF_3 ; and R^6 , R^7 , R^8 , and R^9 independently are hydrogen, halo, C_1 - C_6 alkyl, C_1 - C_6 alkoxy, nitro, or NH_2 ; or

20

A compound of Formula V

-34-



or a pharmaceutically acceptable salt thereof,

wherein n is 0 to 6;

R² is hydrogen, halo, hydroxy, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₂-C₆

5 alkenyl, C₂-C₆ alkynyl, NO₂, NR⁴R⁵, CN, or CF₃;

Each Ar independently is aryl or Het;

Aryl is phenyl or substituted phenyl;

Het is an unsubstituted or substituted heteroaryl group.

10 4. A compound selected from:

Pyrimidine-4,6-dicarboxylic acid, (4-chloro-benzylamide), [(1,3-benzodioxol-5-ylmethyl)-amide];

Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), [(1,3-benzodioxol-5-ylmethyl)-amide];

15 Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (4-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (3-methoxy-benzylamide);

20 Pyrimidine-4,6-dicarboxylic acid, (4-carbomethoxy-benzylamide), (3-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (3-pyridylmethylamide);

Pyrimidine-4,6-dicarboxylic acid, (4-carboxy-benzylamide), (3-thiophenemethylamide);

25 Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzothiadiazol-5-ylmethyl) amide, [(1,3-benzodioxol-5-ylmethyl)-amide];

Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzooxadiazol-5-ylmethyl) amide, [(1,3-benzodioxol-5-ylmethyl)-amide];

-35-

Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzothiadiazol-5-ylmethyl)
amide, (4-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, (2,1,3-benzothiadiazol-5-ylmethyl)
amide, (3-methoxy-benzylamide);

5 Pyrimidine-4,6-dicarboxylic acid bis-(1,3-benzodioxol-5-ylmethyl) ester;

Pyrimidine-4,6-dicarboxylic acid, bis-(4-chloro-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, bis-[(1,3-benzodioxol-5-ylmethyl)-
amide];

Pyrimidine-4,6-dicarboxylic acid, bis-(4-methoxy-benzylamide);

10 Pyrimidine-4,6-dicarboxylic acid, bis-(3-methoxy-benzylamide);

Pyrimidine-4,6-dicarboxylic acid, bis-(4-carboxy-benzylamide); and

Pyrimidine-4,6-dicarboxylic acid, bis-(4-carbomethoxy-benzylamide).

5. A pharmaceutical composition, comprising an MMP-13 inhibiting amount
15 of a compound of Formula I, or a pharmaceutically acceptable salt thereof,
together with a pharmaceutically acceptable carrier, diluent, or excipient;
or

A pharmaceutical composition, comprising an MMP-13 inhibiting amount
20 of a compound of Formula II, or a pharmaceutically acceptable salt
thereof, together with a pharmaceutically acceptable carrier, diluent, or
excipient; or

A pharmaceutical composition, comprising an MMP-13 inhibiting amount
25 of a compound of Formula III, or a pharmaceutically acceptable salt
thereof, together with a pharmaceutically acceptable carrier, diluent, or
excipient; or

A pharmaceutical composition, comprising an MMP-13 inhibiting amount
30 of a compound of Formula IV, or a pharmaceutically acceptable salt
thereof, together with a pharmaceutically acceptable carrier, diluent, or
excipient; or

-36-

A pharmaceutical composition, comprising an MMP-13 inhibiting amount of a compound of Formula V, or a pharmaceutically acceptable salt thereof, together with a pharmaceutically acceptable carrier, diluent, or excipient.

- 5 6. A pharmaceutical composition, comprising a compound of Claim 6, or a pharmaceutically acceptable salt thereof, together with a pharmaceutically acceptable carrier, diluent, or excipient.
7. A method for inhibiting an MMP-13 enzyme in an animal, comprising administering to the animal an MMP-13 inhibiting amount of a compound of Formula I, or a pharmaceutically acceptable salt thereof.
- 10
8. A method for treating cancer, comprising administering to a patient having cancer and in need of treatment an anticancer effective amount of a compound of Formula I, or a pharmaceutically acceptable salt thereof; or
- 15 A method for treating heart failure, comprising administering to a patient in need of treatment an effective amount of a compound of Formula I, or a pharmaceutically acceptable salt thereof; or
- 20 A method for treating inflammation, comprising administering to a patient in need of treatment an effective amount of a compound of Formula I, or a pharmaceutically acceptable salt thereof; or
- 25 A method for treating osteoarthritis, comprising administering to a patient in need of treatment an effective amount of a compound of Formula I, or a pharmaceutically acceptable salt thereof; or
- A method for treating rheumatoid arthritis, comprising administering to a patient in need of treatment an effective amount of a compound of Formula I, or a pharmaceutically acceptable salt thereof.

-37-

9. Use of a compound of Formula I, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of a disease mediated by an MMP-13 enzyme.
- 5 10. Use of a compound of Formula II, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of a disease mediated by an MMP-13 enzyme; or
- 10 Use of a compound of Formula III, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of a disease mediated by an MMP-13 enzyme; or
- 15 Use of a compound of Formula IV, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of a disease mediated by an MMP-13 enzyme; or
- Use of a compound of Formula V, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of a disease mediated by an MMP-13 enzyme.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 02/00190

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C07D239/28 A61K31/505 C07D405/12 C07D401/12 C07D409/12
 C07D413/12 C07D417/12 A61P19/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07D A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, BEILSTEIN Data, CHEM ABS Data, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CHEN J M ET AL: "STRUCTURE-BASED DESIGN OF A NOVEL, POTENT, AND SELECTIVE INHIBITOR FOR MMP-13 UTILIZING NMR SPECTROSCOPY AND COMPUTER-AIDED MOLECULAR DESIGN" JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, AMERICAN CHEMICAL SOCIETY, WASHINGTON, DC, US, vol. 122, 2000, pages 9648-9654, XP001010185 ISSN: 0002-7863 cited in the application the whole document	1-10
X	EP 0 418 797 A (HOECHST AG) 27 March 1991 (1991-03-27) claim 1; examples	3,5,6



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents:

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the international filing date

L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

& document member of the same patent family

Date of the actual completion of the international search

16 May 2002

Date of mailing of the international search report

31/05/2002

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax (+31-70) 340-3016

Authorized officer

Lauro, P

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 02/00190

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 260 057 A (UNIV MELBOURNE ;UNIV SYDNEY (AU)) 16 March 1988 (1988-03-16) examples 6,7,11A ---	3
X	CHEMICAL ABSTRACTS, vol. 125, no. 13, 1996 Columbus, Ohio, US; abstract no. 167964d, page 1162; XP002198554 abstract & JP 08 151380 A (SAGAMI CHEM. RES. CENTER) 11 June 1996 (1996-06-11) * see page 11, compound at the bottom * ---	3,5,6
X	DATABASE CROSSFIRE BEILSTEIN 'Online! Beilstein Institut zur Förderung der Chemischen Wissenschaften, Frankfurt am Main, DE; Database accession no. 786662 XP002198556 abstract & SHKURKO, O. P.; MAMAEV, V. P.: KHIM. GETEROTSIKL. SOEDIN., vol. 6, 1977, pages 821-4, ---	3
X	DATABASE CROSSFIRE BEILSTEIN 'Online! Beilstein Institut zur Förderung der Chemischen Wissenschaften, Frankfurt am Main, DE; Database accession no. 7297869 XP002198557 abstract & YAMAMOTO ET AL.: HETEROCYCLES, vol. 41, no. 6, 1995, pages 1275-90, ---	3
X	DATABASE CROSSFIRE BEILSTEIN 'Online! Beilstein Institut zur Förderung der Chemischen Wissenschaften, Frankfurt am Main, DE; Database accession no. 139954 XP002198558 abstract & J. CHEM. SOC., 1959, pages 525-528, ---	3
X	DATABASE CROSSFIRE BEILSTEIN 'Online! Beilstein Institut zur Förderung der Chemischen Wissenschaften, Frankfurt am Main, DE; Database accession no. 791572 XP002198559 abstract & SAKASAI ET AL.: HETEROCYCLES, vol. 13, 1979, pages 235-236, ---	3

-/--

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 02/00190

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CHEMICAL ABSTRACTS, vol. 79, no. 11, 1973 Columbus, Ohio, US; abstract no. 66394u, page 454; XP002198555 abstract & JP 04 840783 A (BANYU PHARMACEUTICAL CO.) 15 June 1973 (1973-06-15) -----	3

INTERNATIONAL SEARCH REPORT
 nation on patent family members

International Application No
 PCT/1B 02/00190

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0418797	A	27-03-1991	DE 3931432 A1	04-04-1991
			AT 110369 T	15-09-1994
			AU 633142 B2	21-01-1993
			AU 6269890 A	11-04-1991
			AU 635326 B2	18-03-1993
			AU 6269990 A	11-04-1991
			CA 2025799 A1	22-03-1991
			CZ 9004583 A3	18-01-1995
			DD 295835 A5	14-11-1991
			DE 59006893 D1	29-09-1994
			DK 418797 T3	02-01-1995
			EP 0418797 A2	27-03-1991
			ES 2062239 T3	16-12-1994
			HU 55002 A2	29-04-1991
			HU 210822 B3	28-08-1995
			IE 903403 A1	10-04-1991
			IL 95740 A	31-07-1994
			JP 3240776 A	28-10-1991
			LV 10441 A	20-02-1995
			NO 904114 A	22-03-1991
			PL 164989 B1	31-10-1994
			PT 95375 A	22-05-1991
			SU 1836359 A3	23-08-1993
			US 5130317 A	14-07-1992
			ZA 9007535 A	26-06-1991
EP 0260057	A	16-03-1988	EP 0260057 A2	16-03-1988
			AU 595062 B2	22-03-1990
			AU 7769287 A	31-03-1988
			JP 63119471 A	24-05-1988
			US 4873228 A	10-10-1989
			ZA 8706552 A	25-05-1988
JP 8151380	A	11-06-1996	NONE	
JP 4840783	A		NONE	

```
#####          #####          #####          #####          #####          #####          ##          ###          ###
#  #          #  #          #  #          #  #          #  #          #  #          #          #          #
#  #          #  #          #  #          #  #          #  #          #  #          #  #          #  #          #
#  #          ###          #  #          #  #          #####          #  #          #  #          #
#  #          #  #          #####          #  #          #  #          #  #          #  #          #
#  #          #  #          #  #          #  #          #  #          #####          #  #          #
#  #          #  #          #  #          #  #          #  #          #  #          #  #          #
#####          #####          ###          #####          ##          #####          ###          #####          ##
```

Job : 4523
Date: 2004-01-08
Time: 13:46:20

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
22 August 2002 (22.08.2002)

PCT

(10) International Publication Number
WO 02/064578 A1

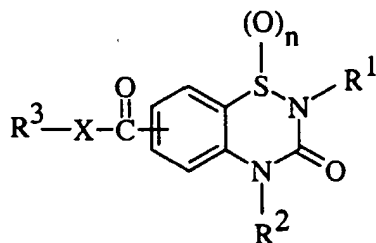
- (51) International Patent Classification⁷: C07D 285/24, A61P 35/00 (74) Agents: LUMB, J., Trevor et al.; Pfizer Inc., 201 Tabor Road, Morris Plains, NJ 07950 (US).
- (21) International Application Number: PCT/IB02/00083 (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (22) International Filing Date: 11 January 2002 (11.01.2002)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 60/268,782 14 February 2001 (14.02.2001) US (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- (71) Applicant (*for all designated States except US*): WARNER-LAMBERT COMPANY [US/US]; 201 Tabor Road, Morris Plains, NJ 07950 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (*for US only*): PICARD, Joseph, Armand [US/US]; Pfizer Global Research and Development, Ann Arbor Laboratories, 2800 Plymouth Road, Ann Arbor, MI 48105 (US). WILSON, Michael, William [US/US]; Pfizer Global Research and Development, Ann Arbor Laboratories, 2800 Plymouth Road, Ann Arbor, MI 48105 (US).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: BENZO THIADIAZINE MATRIX METALLOPROTEINASE INHIBITORS



(I)

(57) Abstract: Selective MMP-13 inhibitors are benzo thiadiazines of the Formula (I) or a pharmaceutically acceptable salt thereof, wherein R² is hydrogen or alkyl; R¹ and R³ include hydrogen, alkyl, and aryl, with the proviso that R³ is not (CH₂)_m biphenyl or (CH₂)_m substituted biphenyl; X is O or NH, n is 0, 1, or 2. The compounds of Formula (I), or a pharmaceutically acceptable salt thereof, are useful for treating diseases mediated by an MMP-13 enzyme, including diseases selected from osteoarthritis, rheumatoid arthritis, cancer, inflammation, and heart failure.



WO 02/064578 A1

-1-

BENZO THIADIAZINE MATRIX METALLOPROTEINASE INHIBITORS

FIELD OF THE INVENTION

This invention relates to a group of benzo thiadiazine derivatives which inhibit matrix metalloproteinase enzymes, and thus are useful for treating diseases resulting from tissue breakdown, such as heart disease, multiple sclerosis, arthritis, atherosclerosis, and osteoporosis.

BACKGROUND OF THE INVENTION

Matrix metalloproteinases (sometimes referred to as MMPs) are naturally occurring enzymes found in most mammals. Over-expression and activation of MMPs or an imbalance between MMPs and inhibitors of MMPs have been suggested as factors in the pathogenesis of diseases characterized by the breakdown of extracellular matrix or connective tissues.

Stromelysin-1 and gelatinase A are members of the matrix metalloproteinases (MMP) family. Other members include fibroblast collagenase (MMP-1), neutrophil collagenase (MMP-8), gelatinase B (92 kDa gelatinase) (MMP-9), stromelysin-2 (MMP-10), stromelysin-3 (MMP-11), matrilysin (MMP-7), collagenase 3 (MMP-13), TNF-alpha converting enzyme (TACE), and other newly discovered membrane-associated matrix metalloproteinases (Sato H., Takino T., Okada Y., Cao J., Shinagawa A., Yamamoto E., and Seiki M., *Nature*, 1994;370:61-65). These enzymes have been implicated with a number of diseases which result from breakdown of connective tissue, including such diseases as rheumatoid arthritis, osteoarthritis, osteoporosis, periodontitis, multiple sclerosis, gingivitis, corneal epidermal and gastric ulceration, atherosclerosis, neointimal proliferation which leads to restenosis and ischemic heart failure, and tumor metastasis. A method for preventing and treating these and other diseases is now recognized to be by inhibiting metalloproteinase enzymes, thereby curtailing and/or eliminating the breakdown of connective tissues that results in the disease states.

-2-

The catalytic zinc in matrix metalloproteinases is typically the focal point for inhibitor design. The modification of substrates by introducing zinc chelating groups has generated potent inhibitors such as peptide hydroxamates and thiol-containing peptides. Peptide hydroxamates and the natural endogenous inhibitors of MMPs (TIMPs) have been used successfully to treat animal models of cancer and inflammation. MMP inhibitors have also been used to prevent and treat congestive heart failure and other cardiovascular diseases, United States Patent Number 5,948,780.

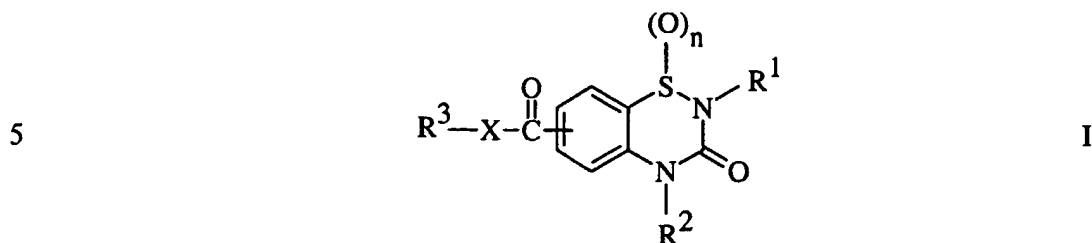
A major limitation on the use of currently known MMP inhibitors is their lack of specificity for any particular enzyme. Recent data has established that specific MMP enzymes are associated with some diseases, with no effect on others. The MMPs are generally categorized based on their substrate specificity, and indeed the collagenase subfamily of MMP-1, MMP-8, and MMP-13 selectively cleave native interstitial collagens, and thus are associated only with diseases linked to such interstitial collagen tissue. This is evidenced by the recent discovery that MMP-13 alone is overexpressed in breast carcinoma, while MMP-1 alone is overexpressed in papillary carcinoma (see Chen et al., *J. Am. Chem. Soc.*, 2000;122:9648-9654).

There appears to be few selective inhibitors of MMP-13 reported. A compound named WAY-170523 has been reported by Chen et al., supra., 2000, and a few other compounds are reported in PCT international application publication number WO 01/63244 A1, as allegedly selective inhibitors of MMP-13. Further, United States Patent Number 6,008,243 discloses inhibitors of MMP-13. However, no selective or nonselective inhibitor of MMP-13 has been approved and marketed for the treatment of any disease in any mammal. Accordingly, the need continues to find new low molecular weight compounds that are potent and selective MMP inhibitors, and that have an acceptable therapeutic index of toxicity/potency to make them amenable for use clinically in the prevention and treatment of the associated disease states. An object of this invention is to provide a group of selective MMP-13 inhibitor compounds characterized as being benzo thiadiazines.

-3-

SUMMARY OF THE INVENTION

This invention provides a group of benzo thiadiazine compounds that are inhibitors of matrix metalloproteinase enzymes, and especially MMP-13. The invention is more particularly directed to compounds defined by Formula I



or a pharmaceutically acceptable salt thereof, wherein:

n is 0, 1, or 2;

X is O or NH;

R² is H, C₁-C₆ alkyl, or C₁-C₆ substituted alkyl;

10 R¹ and R³ independently are H, acyl, substituted acyl, C₁-C₆ alkyl, C₁-C₆ substituted alkyl, C₂-C₆ alkenyl, C₂-C₆ substituted alkenyl, C₂-C₆ alkynyl, C₁-C₆ substituted alkynyl, (CH₂)_m aryl, (CH₂)_m substituted aryl, (CH₂)_m heteroaryl, (CH₂)_m substituted heteroaryl, (CH₂)_m cycloalkyl, or (CH₂)_m substituted cycloalkyl; and

15 each m independently is an integer of from 0 to 6,

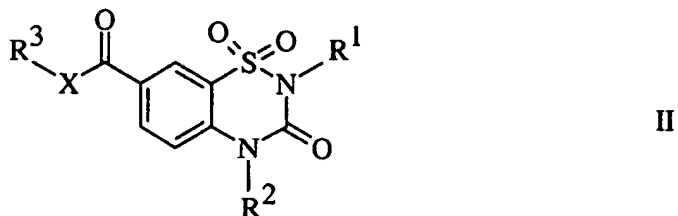
with the proviso that R³ is not (CH₂)_m biphenyl or (CH₂)_m substituted biphenyl.

Preferred compounds have Formula I wherein R¹ and R³ are not both selected from H or C₁-C₆ alkyl. Also preferred are compounds of Formula I

wherein R³ is not acyl or substituted acyl when X is O. Other preferred

20 compounds have Formula I wherein each m is 1.

Preferred compounds have Formula II



-4-

wherein R^1 , R^2 , R^3 , and X are as defined above.

Also preferred are compounds of Formulas I and II wherein R_2 is H, alkyl or substituted alkyl, and R^1 and R^3 independently are $(CH_2)_m$ phenyl, $(CH_2)_m$ heteroaryl, $(CH_2)_m$ cycloalkyl, C_2-C_6 alkenyl, or C_2-C_6 substituted alkenyl, wherein phenyl, heteroaryl, and cycloalkyl may be unsubstituted or substituted.

Especially preferred compounds have Formulas I and II wherein R^2 is hydrogen or C_1-C_6 alkyl, and R^1 and R^3 independently are C_1-C_6 substituted alkyl, wherein at least one substituent is an aryl group such as phenyl or substituted phenyl.

Still more preferred is a compound of Formula I, or a pharmaceutically acceptable salt thereof, selected from:

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-

1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid benzyl ester;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-

1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-

1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-

benzo[1,2,4]thiadiazine-7-carboxylic acid (1H-indol-5-ylmethyl)-amide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-

benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-

benzo[1,2,4]thiadiazine-7-carboxylic acid 4-(2-*tert*-butylsulfamoyl-ethyl)-benzylamide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-

benzo[1,2,4]thiadiazine-7-carboxylic acid (1H-indol-2-ylmethyl)-amide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-

benzo[1,2,4]thiadiazine-7-carboxylic acid 4-(2-sulfamoyl-ethyl)-benzylamide;

2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-

1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

-5-

- 4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1/6-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1/6-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 5 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1/6-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid *tert*-butyl ester;
- 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1/6-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid;
- 10 2-(4-Carbamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-fluoro-benzylamide;
- 15 4-Methyl-2-(4-nitro-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 4-Methyl-2-[4-(morpholine-4-sulfonyl)-benzyl]-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 20 4-[7-(4-Fluoro-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1/6-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid methyl ester;
- 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid (2-methoxy-pyridin-4-ylmethyl)-amide;
- 25 4-Methyl-2-naphthalen-2-ylmethyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-Biphenyl-4-ylmethyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

-6-

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -
benzo[1,2,4]thiadiazine-7-carboxylic acid (2,1,3-benzothiadiazol-5-ylmethyl)-
amide;

4-[7-(4-Fluoro-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-
5 1 λ^6 -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid;

4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-
1H-1 λ^6 -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid 2-dimethylamino-ethyl
ester hydrochloride;

4-Methyl-1,1,3-trioxo-2-[4-(piperidine-1-carbonyl)-benzyl]-1,2,3,4-
10 tetrahydro-1 λ^6 -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-{4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-
1H-1 λ^6 -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoylamino}-3-methyl-butyric acid;

2-(4-Cyano-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
15 {4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-
1H-1 λ^6 -benzo[1,2,4]thiadiazin-2-ylmethyl]-phenyl}-acetic acid;

4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-
1H-1 λ^6 -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid;

4-Methyl-1,1,3-trioxo-2-[4-(2H-tetrazol-5-yl)-benzyl]-1,2,3,4-tetrahydro-
20 1 λ^6 -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-(4-Amino-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -
benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;

4-Methyl-1,1,3-trioxo-2-pent-2-ynyl-1,2,3,4-tetrahydro-1 λ^6 -
25 benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

4-Methyl-1,1,3-trioxo-2-(1-phenyl-ethyl)-1,2,3,4-tetrahydro-1 λ^6 -
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-(5-Cyano-pentyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -
30 benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

-7-

2-(E)-But-2-enyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

4-Methyl-1,1,3-trioxo-2-(E)-pent-2-enyl-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

5 4-Methyl-2-(2-methyl-allyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

4-Methyl-2-(3-methyl-but-2-enyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

10 4-Methyl-1,1,3-trioxo-2-[2-(toluene-4-sulfonyl)-ethyl]-1,2,3,4-tetrahydro-
1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-[3-(4-Fluoro-phenyl)-3-oxo-propyl]-4-methyl-1,1,3-trioxo-1,2,3,4-
tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

4-Methyl-1,1,3-trioxo-2-{2-[(1-phenyl-methanoyl)-amino]-ethyl}-1,2,3,4-
tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

15 2-Benzo[1,2,5]oxadiazol-5-ylmethyl-4-methyl-1,1,3-trioxo-1,2,3,4-
tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

{5-[7-(4-Methoxy-benzylcarbonyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-
1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-isoxazol-3-yl}-carbamic acid methyl
ester; and

20 4-Methyl-1,1,3-trioxo-2-thiazol-4-ylmethyl-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide.

Other preferred invention compounds are selected from:

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;

25 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;

4-(7-Benzylcarbonyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-
30 benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;

-8-

- 4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 5 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 10 4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 15 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- {4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid *tert*-butyl ester;
- 20 {4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid *tert*-butyl ester;
- {4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid *tert*-butyl ester;
- 25 {4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid *tert*-butyl ester;
- {4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid *tert*-butyl ester;
- 30

-9-

- {4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;
- {4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;
- 5 {4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;
- {4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;
- {4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;
- 10 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1*l*⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;
- 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1*l*⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;
- 15 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1*l*⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;
- 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1*l*⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1*l*⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;
- 20 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1*l*⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;
- 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1*l*⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;
- 25 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1*l*⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;
- 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1*l*⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1*l*⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;
- 30

-10-

- 2-(4-Dimethylsulfamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;
- 2-(4-Dimethylsulfamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;
- 5 2-(4-Dimethylsulfamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;
- 2-(4-Dimethylsulfamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-(4-Dimethylsulfamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;
- 10 2-Benzyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;
- 2-Benzyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;
- 15 2-Benzyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;
- 2-Benzyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-Benzyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;
- 20 4-(7-Benzylcarbamoyl-1,1,3-trioxo-3,4-dihydro-1*H*-1 β -benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 4-(1,1,3-Trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1 β -benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 25 4-(1,1,3-Trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1 β -benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 4-[7-(4-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1*H*-1 β -benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 4-[7-(3-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1*H*-1 β -benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 30

-11-

- 4-(7-Benzylcarbamoyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 4-(1,1,3-Trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 5 4-(1,1,3-Trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 4-[7-(4-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 4-[7-(3-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 10 {4-(7-Benzylcarbamoyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid *tert*-butyl ester;
- {4-(1,1,3-Trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid *tert*-butyl ester;
- 15 {4-(1,1,3-Trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid *tert*-butyl ester;
- {4-[7-(4-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid *tert*-butyl ester;
- {4-[7-(3-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid *tert*-butyl ester;
- 20 {4-(7-Benzylcarbamoyl-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;
- {4-(1,1,3-Trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;
- 25 {4-(1,1,3-Trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;
- {4-[7-(4-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;
- {4-[7-(3-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1*H*-1*l*⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;
- 30

-12-

2-(4-Methanesulfonyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

2-(4-Methanesulfonyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;

5 2-(4-Methanesulfonyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;

2-(4-Methanesulfonyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

10 2-(4-Methanesulfonyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;

2-(4-Methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

2-(4-Methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;

15 2-(4-Methylsulfamoyl-benzyl) -1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;

2-(4-Methylsulfamoyl-benzyl) -1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

20 2-(4-Methylsulfamoyl-benzyl) -1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;

2-(4-Dimethylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

2-(4-Dimethylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;

25 2-(4-Dimethylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;

2-(4-Dimethylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide; and

30 2-(4-Dimethylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide.

-13-

A further embodiment of this invention is use of a compound of Formula I, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of a disease mediated by an MMP-13 enzyme.

5 Preferred is use of a compound of Formula II, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of a disease mediated by an MMP-13 enzyme.

Also preferred is use of a compound of Formula I, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of cancer.

10 Also preferred is use of a compound of Formula I, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of rheumatoid arthritis.

Also preferred is use of a compound of Formula I, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of
15 osteoarthritis.

Also preferred is use of a compound of Formula I, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of heart failure.

A further embodiment of this invention is a pharmaceutical composition,
20 comprising a compound of Formula I, or a pharmaceutically acceptable salt thereof, admixed with a pharmaceutically acceptable carrier, excipient, or diluent. Preferred compositions comprise a compound of Formula II, or a pharmaceutically acceptable salt thereof, together with a pharmaceutically acceptable carrier, excipient, or diluent.

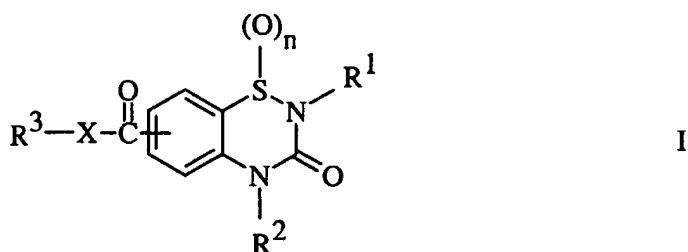
25 Another embodiment of this invention is a method for inhibiting an MMP-13 enzyme in an animal, comprising administering to the animal an MMP-13 inhibiting amount of a compound of Formula I, or a pharmaceutically acceptable salt thereof.

A further embodiment is a method for treating a disease mediated by an
30 MMP-13 enzyme, comprising administering to a patient suffering from such a disease an effective amount of a compound of Formula I, or a pharmaceutically acceptable salt thereof.

-14-

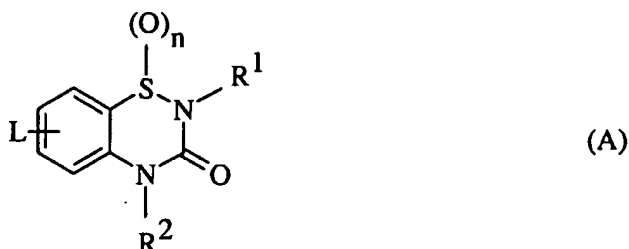
A preferred method of treatment according to this invention is treatment of a disease selected from cancer, especially breast carcinoma, inflammation and heart failure. Other diseases to be treated according to preferred aspect of this invention include rheumatoid arthritis and osteoarthritis.

- 5 Another embodiment of the present invention is a process for preparing a compound of Formula I



or a pharmaceutically acceptable salt thereof, wherein:

- n is 0, 1, or 2;
- 10 X is O or NH;
- R² is H, C₁-C₆ alkyl, or C₁-C₆ substituted alkyl;
- R¹ and R³ independently are H, acyl, substituted acyl, C₁-C₆ alkyl, C₁-C₆ substituted alkyl, C₂-C₆ alkenyl, C₂-C₆ substituted alkenyl, C₂-C₆ alkynyl, C₁-C₆ alkynyl, (CH₂)_m aryl, (CH₂)_m substituted aryl, (CH₂)_m heteroaryl, (CH₂)_m substituted heteroaryl, (CH₂)_m cycloalkyl, or (CH₂)_m substituted cycloalkyl; and
- 15 each m independently is an integer of from 0 to 6, with the proviso that R₃ is not (CH₂)_m biphenyl or (CH₂)_m substituted biphenyl,
- 20 the process comprising the step of:
contacting a compound of Formula (A)



-15-

wherein n , R^1 , and R^2 are as defined above, and

L is CO_2H , CO_2M , $C(=O)$ -halo, $C(=O)-OR^7$, $C(=O)NR^8R^9$, $C(=O)-C(halo)_3$, or $C\equiv N$, wherein R^7 is pentafluorophenyl, $C(=O)R^2$, or $S(O)R^2$, wherein R^2 is as defined above;

- 5 R^8 and R^9 are taken together with the nitrogen atom to which they are attached to form imidazol-1-yl, phthalimid-1-yl, benzotriazol-1-yl, or tetrazol-1-yl; and M is an alkalai earth metal cation or alkaline earth metal cation, with a solvent and a compound of Formula (B)



- 10 wherein R^3 is as defined above and D is HO , H_2N , MO , or $MN(H)$, wherein M is as defined above, optionally in the presence of from 1 to 3 agents selected from:

a coupling agent, a tertiary organic amine, an acid catalyst, a base catalyst, an acid halide, and an acid anhydride.

- 15 Preferred is the invention process, wherein n is 2; or

Preferred is the invention process, wherein n is 2 and X is O ; or

Preferred is the invention process, wherein n is 2 and X is NH ; or

- Preferred is the invention process, wherein R^1 and R^3 independently are $(CH_2)_m$ aryl, $(CH_2)_m$ substituted aryl, $(CH_2)_m$ heteroaryl, $(CH_2)_m$ substituted heteroaryl.

- 20 More preferred is any one of the above embodiments of the invention process wherein L is CO_2H , CO_2M , or $C(=O)$ -halo.

DETAILED DESCRIPTION OF THE INVENTION

The compounds provided by this invention are those defined by Formula I.

- 25 In Formula I, R^1 to R^3 include "C₁-C₆ alkyl" groups. These are straight and branched carbon chains having from 1 to 6 carbon atoms. Examples of such alkyl groups include methyl, ethyl, isopropyl, *tert*-butyl, neopentyl, and n-hexyl. The

-16-

alkyl groups can be substituted if desired, for instance with groups such as hydroxy, alkoxy, amino, alkyl and dialkylamino, alkanoyl, acyl, halo, trifluoromethyl, carboxy, nitro, and cyano.

5 “Alkenyl” means straight and branched hydrocarbon radicals having from 2 to 6 carbon atoms and one double bond and includes ethenyl, 3-buten-1-yl, 2-ethenylbutyl, 3-hexen-1-yl, and the like.

 “Alkynyl” means straight and branched hydrocarbon radicals having from 2 to 6 carbon atoms and one triple bond and includes ethynyl, 3-butyn-1-yl, propynyl, 2-butyn-1-yl, 3-pentyn-1-yl, and the like.

10 “Cycloalkyl” means a monocyclic or polycyclic hydrocarbyl group such as cyclopropyl, cycloheptyl, cyclooctyl, cyclodecyl, cyclobutyl, adamantyl, norpinanyl, decalanyl, norbornyl, cyclohexyl, and cyclopentyl. Such groups can be substituted with groups such as hydroxy, keto, and the like. Also included are rings in which 1 to 3 heteroatoms replace carbons. Such groups are termed
15 “heterocycle” or “heterocyclyl”, which means a cycloalkyl group also bearing at least one heteroatom selected from O, S, or NR^2 , examples being oxiranyl, pyrrolidinyl, piperidyl, tetrahydropyran, and morpholine.

 “Alkoxy” refers to the alkyl groups mentioned above bound through oxygen, examples of which include methoxy, ethoxy, isopropoxy, *tert*-butoxy, and
20 the like. In addition, alkoxy refers to polyethers such as $-\text{O}-(\text{CH}_2)_2-\text{O}-\text{CH}_3$, and the like. “Thioalkoxy” is an alkoxy group wherein the O is replaced by an S.

 “Alkanoyl” groups are alkyl linked through a carbonyl, ie, $\text{C}_1-\text{C}_5-\text{C}(\text{O})-$. Such groups include formyl, acetyl, propionyl, butyryl, and isobutyryl.

 “Acyl” means an R group that is a C_1-C_6 alkyl or aryl (Ar) group bonded
25 through a carbonyl group, i.e., $\text{R}-\text{C}(\text{O})-$, wherein C_1-C_6 alkyl and aryl are as defined above and below, respectively. The phrase “substituted acyl” means an R group that is a substituted C_1-C_6 alkyl or a substituted aryl (substituted Ar) group bonded through a carbonyl group. For example, substituted acyl includes substituted alkanoyl, wherein the alkyl portion can be substituted by NR^4R^5 or a
30 carboxylic or heterocyclic group. Typical acyl groups include acetyl, benzoyl, and the like. Typical substituted acyl groups include trifluoroacetyl, 4-carboxybenzoyl, and the like.

-17-

The alkyl, alkenyl, alkoxy, and alkynyl groups described above are optionally substituted, preferably by 1 to 3 groups selected from NR^4R^5 , phenyl, substituted phenyl, $(\text{CH}_2)_m\text{-C(O)}$ phenyl, $(\text{CH}_2)_m\text{C(O)}$ substituted phenyl, $(\text{CH}_2)_m\text{-S(O)}_{0-2}$ phenyl, $(\text{CH}_2)_m\text{S(O)}_{0-2}$ substituted phenyl,
 5 $(\text{CH}_2)_m\text{-C(O)}$ heteroaryl, $(\text{CH}_2)_m\text{C(O)}$ substituted heteroaryl, $(\text{CH}_2)_m\text{-S(O)}_{0-2}$ heteroaryl, $(\text{CH}_2)_m\text{-S(O)}_{0-2}$ substituted heteroaryl, $(\text{CH}_2)_m$ cycloalkyl, heterocycle, thio $\text{C}_1\text{-C}_6$ alkyl, $\text{C}_1\text{-C}_6$ alkoxy, hydroxy, acyl, carboxy, alkanoyl, $\text{C}_1\text{-C}_6$ alkoxycarbonyl, halo, nitro, nitrile, cycloalkyl, and a 5-
 10 or 6-membered carbocyclic ring or heterocyclic ring having 1 or 2 heteroatoms selected from nitrogen, substituted nitrogen, oxygen, and sulfur. "Substituted nitrogen" means nitrogen bearing $\text{C}_1\text{-C}_6$ alkyl or $(\text{CH}_2)_y\text{Ph}$ where y is 1, 2, or 3. Perhalo and polyhalo substitution is also embraced.

R^4 and R^5 independently are hydrogen, $\text{C}_1\text{-C}_6$ alkyl, $\text{C}_2\text{-C}_6$ alkenyl, $\text{C}_2\text{-C}_6$ alkynyl, acyl, $(\text{CH}_2)_m$ aryl, $(\text{CH}_2)_m$ heteroaryl, $(\text{CH}_2)_m$ cycloalkyl,
 15 wherein these groups may be unsubstituted or substituted as described herein, or R^4 and R^5 are taken together with the nitrogen atom to which they are attached to form a 3- to 7-membered ring containing carbon atoms, the nitrogen atom bearing R^4 and R^5 , and optionally 1 or 2 heteroatoms selected from O, S, NH, and NR^2 , wherein R^2 is as defined above, the ring optionally may be substituted with oxo
 20 ("=O") on a carbon atom.

Examples of NR^4R^5 groups include amino, methylamino, di-isopropylamino, acetyl amino, propionyl amino, 3-aminopropyl amino, 3-ethylaminobutyl amino, 3-di-n-propylamino-propyl amino, 4-diethylaminobutyl amino, and 3-carboxypropionyl amino. R^4 and R^5 can be taken together with the
 25 nitrogen to which they are attached to form a ring having 3 to 7 carbon atoms and 1, 2, or 3 heteroatoms selected from the group consisting of nitrogen, substituted nitrogen, oxygen, and sulfur. Examples of such cyclic NR^4R^5 groups include pyrrolidinyl, piperazinyl, 4-methylpiperazinyl, 4-benzylpiperazinyl, pyridinyl, piperidinyl, pyrazinal, morpholinyl, and the like.

30 "Halo" includes fluoro, chloro, bromo, and iodo.

-18-

Examples of substituted alkyl groups include 2-aminoethyl, pentachloroethyl, trifluoromethyl, 2-diethylaminoethyl, 2-dimethylaminopropyl, ethoxycarbonylmethyl, 3-phenylbutyl, methanysulfanylmethyl, methoxymethyl, 3-hydroxypentyl, 2-carboxybutyl, 4-chlorobutyl, 3-cyclopropylpropyl, pentafluoroethyl, benzyl(B_n), 3-morpholinopropyl, piperazinylmethyl, pyridyl-4-methyl(Py-4-me), 3-(pyridyl-4-thio)propyl, and 2-(4-methylpiperazinyl)ethyl.

Examples of substituted alkynyl groups include 2-methoxyethynyl, 2-ethylsulfanyethynyl, 4-(1-piperazinyl)-3-(butynyl), 3-phenyl-5-hexynyl, 3-diethylamino-3-butynyl, 4-chloro-3-butynyl, 4-cyclobutyl-4-hexenyl, and the like.

Typical substituted alkoxy groups include aminomethoxy, trifluoromethoxy, 2-diethylaminoethoxy, 2-ethoxycarbonylethoxy, 3-hydroxypropoxy, 6-carboxhexyloxy, and the like.

Further, examples of substituted alkyl, alkenyl, and alkynyl groups include dimethylaminomethyl, carboxymethyl, 4-dimethylamino-3-buten-1-yl, 5-ethylmethylamino-3-pentyn-1-yl, 4-morpholinobutyl, 4-tetrahydropyridinylbutyl, 3-imidazolidin-1-ylpropyl, 4-tetrahydrothiazol-3-yl-butyl, phenylmethyl, 3-chlorophenylmethyl, and the like.

The terms "Ar" and "aryl" refer to unsubstituted and substituted aromatic groups. Heteroaryl groups have from 4 to 10 ring atoms, from 1 to 4 of which are independently selected from the group consisting of O, S, and N. Preferred heteroaryl groups have 1 or 2 heteroatoms in a 5- or 6-membered aromatic ring. Mono- and bicyclic aromatic ring systems are included in the definition of aryl and heteroaryl. Typical aryl and heteroaryl groups include phenyl, 3-chlorophenyl, 3,4-methylenedioxyphenyl, 2,6-dibromophenyl, pyridyl, 3-methylpyridyl, 4-thiopyridyl, benzothienyl, 2,4,6-tribromophenyl, 4-ethylbenzothienyl, furanyl, 3,4-diethylfuranyl, naphthyl, 4,7-dichloronaphthyl, morpholinyl, indolyl, benzotriazolyl, indazolyl, pyrrole, pyrazole, imidazole, thiazole, and the like.

Preferred Ar groups are phenyl or naphthyl, and phenyl or naphthyl substituted by 1, 2, or 3 groups independently selected from the group consisting of alkyl, alkoxy, thio, thioalkyl, thioalkoxy, (CH₂)_mN(R⁴)S(O)₂(C₁-C₆ alkyl), (CH₂)_mS(O)₂NR⁴R⁵, wherein R⁴, R⁵, and m are as defined above,

-19-

$S(O)_2NR^4R^5$, $C(O)NR^4R^5$, $N(H)C(O)NR^4R^5$, $O-C(O)NR^4R^5$, halo, hydroxy,
 $-COOR^6$, trifluoromethyl, nitro, amino of the formula $-NR^4R^5$, $C(O)NR^4R^5$,
 $S(O)C_1-C_6$ alkyl, $S(O)_2C_1-C_6$ alkyl, 5-membered heteroaryl,
 $N(R^5)C(O)O(C_1-C_6 \text{ alkyl})$, and $T(CH_2)_pQR^4$ or $T(CH_2)_pCO_2R^4$, wherein p is
 1 to 6, T is O, S, SO, SO_2 , NR^4 , $N(O)R^4$, NR^4R^6Y , or CR^4R^5 , Q is O, S, SO,
 SO_2 , NR^5 , $N(O)R^5$, or NR^5R^6Y , wherein R^4 and R^5 are as described above, Y is
 a counterion such as halo, R^6 is H, C_1-C_6 alkyl, or substituted C_1-C_6 alkyl, for
 example, methyl, trichloroethyl, diphenylmethyl, and the like. The alkyl and
 alkoxy groups can be substituted as defined above. For example, typical groups
 are carboxyalkyl, alkoxycarbonylalkyl, hydroxyalkyl, hydroxyalkoxy, and
 alkoxyalkyl. Examples of substituted phenyl are 3-methoxyphenyl,
 2,6-dichlorophenyl, 3-nitrophenyl, 4-dimethylaminophenyl, and biphenyl.
 Examples of quaternary ammonium groups defined by NR^4R^6Y are
 trimethylammonium chloride and triethylammonium bromide.

Heteroaryl groups may be substituted with up to 3 groups independently
 selected from the 1, 2, or 3 groups described above for substituted phenyl.

The phrase "tertiary organic amine" means a trisubstituted nitrogen group
 wherein the 3 substituents are independently selected from C_1-C_{12} alkyl,
 C_3-C_{12} cycloalkyl, benzyl, or wherein two of the substituents are taken together
 with the nitrogen atom to which they are attached to form a 5- or 6-membered,
 monocyclic heterocycle containing one nitrogen atom and carbon atoms, and the
 third substituent is selected from C_1-C_{12} alkyl and benzyl, or wherein the three
 substituents are taken together with the nitrogen atom to which they are attached
 to form a 7- to 12-membered bicyclic heterocycle containing 1 or 2 nitrogen
 atoms and carbon atoms, and optionally a C=N double bond when 2 nitrogen
 atoms are present. Illustrative examples of tertiary organic amine include
 triethylamine, diisopropylethylamine, benzyl diethylamino, dicyclohexylmethyl-
 amine, 1,8-diazabicyclo[5.4.0]undec-7-ene ("DBU"),
 1,4-diazabicyclo[2.2.2]octane ("TED"), and 1,5-diazabicyclo[4.3.0]non-5-ene.

-20-

The term "coupling agent" includes any reagent, or any combination of two, three, or four reagents, conventionally used to promote coupling of a carboxylic acid, or a pharmaceutically acceptable salt thereof, with an alcohol or an amine to yield a carboxylic ester or carboxylic amide, respectively. The coupling agents are described in *Reagents for Organic Synthesis*, by Fieser and Fieser, John Wiley & Sons, Inc., New York, 2000; *Comprehensive Organic Transformations*, by Richard C. Larock, VCH Publishers, Inc., New York, 1989; the series *Compendium of Organic Synthetic Methods* (1989) by Wiley-Interscience; and the text *Advanced Organic Chemistry*, 5th edition, by Jerry March, Wiley-Interscience, New York (2001). Illustrative examples of coupling agents include N,N'-carbonyldiimidazole ("CDI"), N, N'-dicyclohexylcarbodiimide ("DCC"), triphenylphosphine with diethylazodicarboxylate, bis(2-oxo-3-oxazolidinyl)phosphinic chloride ("BOP-Cl"), POCl₃, Ti(Cl)₄, and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride ("EDAC").

The phrase "acid catalyst" means any protic or Lewis acid that is conventionally used to catalyze coupling of a carboxylic acid, or a pharmaceutically acceptable salt thereof, a nitrile, carboxylic ester, carboxylic amide, carboxylic acid halide, or carboxylic acid anhydride with an alcohol or an amine to yield a carboxylic ester or carboxylic amide, respectively. The acid catalysts are described in *Reagents for Organic Synthesis*, by Fieser and Fieser, John Wiley & Sons, Inc., New York, 2000; *Comprehensive Organic Transformations*, by Richard C. Larock, VCH Publishers, Inc., New York, 1989; the series *Compendium of Organic Synthetic Methods* (1989) by Wiley-Interscience; and the text *Advanced Organic Chemistry*, 5th edition, by Jerry March, Wiley-Interscience, New York (2001). Illustrative examples include anhydrous hydrogen chloride, hydrochloric acid, hydrogen bromide in acetic acid, zinc chloride, titanium tetrachloride, acetic acid, trifluoroacetic acid, phenol, sulfuric acid, methanesulfonic acid, magnesium sulfate, Amberlyst-15 resin, silica gel, and the like.

It should be appreciated that a nitrile may be contacted with an alcohol or an amine in the presence of an acid catalyst, and the resulting intermediate imidate

-21-

or amidine, respectively, may be contacted with water to yield the carboxylic ester or carboxylic amide, respectively.

The phrase "base catalyst" means any base that is conventionally used to catalyze coupling of a carboxylic acid, or a pharmaceutically acceptable salt thereof, carboxylic ester, carboxylic amide, carboxylic acid halide, or carboxylic acid anhydride with an alcohol or an amine to yield a carboxylic ester or carboxylic amide, respectively. The base catalysts are described in *Reagents for Organic Synthesis*, by Fieser and Fieser, John Wiley & Sons, Inc., New York, 2000; *Comprehensive Organic Transformations*, by Richard C. Larock, VCH Publishers, Inc., New York, 1989; the series *Compendium of Organic Synthetic Methods* (1989) by Wiley-Interscience; and the text *Advanced Organic Chemistry*, 5th edition, by Jerry March, Wiley-Interscience, New York (2001). Illustrative examples include sodium hydroxide, sodium hydride, potassium tert-butoxide, a tertiary organic amine, titanium tetraisopropoxide, sodium methoxide, sodium acetate, sodium bicarbonate, potassium carbonate, basic alumina, and the like.

The phrase "acid halide" means any carboxylic acid halide or sulfonic acid halide that is conventionally used to catalyze coupling of a carboxylic acid, or a pharmaceutically acceptable salt thereof, with an alcohol or an amine to yield a carboxylic ester or carboxylic amide, respectively. The acid halides are described in *Reagents for Organic Synthesis*, by Fieser and Fieser, John Wiley & Sons, Inc., New York, 2000; *Comprehensive Organic Transformations*, by Richard C. Larock, VCH Publishers, Inc., New York, 1989; the series *Compendium of Organic Synthetic Methods* (1989) by Wiley-Interscience; and the text *Advanced Organic Chemistry*, 5th edition, by Jerry March, Wiley-Interscience, New York (2001). Illustrative examples include acetyl chloride, trifluoromethanesulfonyl chloride, 2,2-dimethylacetyl bromide, para-toluenesulfonyl chloride, pentafluorobenzoyl chloride, and the like.

The phrase "acid anhydride" means any carboxylic acid anhydride or sulfonic acid anhydride that is conventionally used to catalyze coupling of a carboxylic acid, or a pharmaceutically acceptable salt thereof, with an alcohol or an amine to yield a carboxylic ester or carboxylic amide, respectively. The acid anhydrides are described in *Reagents for Organic Synthesis*, by Fieser and Fieser,

-22-

John Wiley & Sons, Inc., New York, 2000; *Comprehensive Organic Transformations*, by Richard C. Larock, VCH Publishers, Inc., New York, 1989; the series *Compendium of Organic Synthetic Methods* (1989) by Wiley-Interscience; and the text *Advanced Organic Chemistry*, 5th edition, by Jerry March, Wiley-Interscience, New York (2001). Illustrative examples include acetic anhydride, trifluoroacetic anhydride, trifluoromethanesulfonic acid anhydride, pentafluoro-benzoic anhydride, mixed anhydrides like trifluoroacetyloxycarbonylmethyl, and the like.

The term "halide" includes fluoride, chloride, bromide, and iodide.

The phrase "coupling catalyst" means any metal catalyst, preferably a transition metal catalyst, that is conventionally used to catalyze coupling of an aryl halide, aryl trifluoromethanesulfonate, heteroaryl halide, or heteroaryl trifluoromethanesulfonate, or activated derivatives thereof, including arylboronic acids, heteroarylboronic acids, aryl stannanes, heteroarylstannanes, aryl magnesium halides, heteroaryl magnesium halides, aryl lithiums, or heteroaryl lithiums, with an terminal alkyne to yield an arylalkyne or heteroarylalkyne. The coupling catalysts are described in *Reagents for Organic Synthesis*, by Fieser and Fieser, John Wiley & Sons, Inc., New York, 2000; *Comprehensive Organic Transformations*, by Richard C. Larock, VCH Publishers, Inc., New York, 1989; the series *Compendium of Organic Synthetic Methods* (1989) by Wiley-Interscience; and the text *Advanced Organic Chemistry*, 5th edition, by Jerry March, Wiley-Interscience, New York (2001). Illustrative examples of coupling catalysts include tetrakis(triphenylphosphine)palladium (0), palladium (II) chloride, palladium (II) acetate, iron (III) chloride, Heck reaction catalysts, Suzuki reaction catalysts, Stille reaction catalysts, and the like.

The group "S(O)₀₋₂" means S, S(=O), or S(=O)₂.

The descriptors "1⁶" and "1_λ⁶" are synonymous.

The term "comprising", which is synonymous with the terms "including", "containing", or "characterized by", is inclusive or open-ended, and does not exclude additional, unrecited elements or method steps from the scope of the invention that is described following the term.

-23-

The phrase "consisting of" is closed-ended, and excludes any element, step, or ingredient not specified in the description of the invention that follows the phrase.

5 The phrase "consisting essentially of" limits the scope of the invention that follows to the specified elements, steps, or ingredients, and those further elements, steps, or ingredients that do not materially affect the basic and novel characteristics of the invention.

The term "patient" means a mammal. Preferred patients include humans, cats, dogs, cows, horses, pigs, and sheep.

10 The term "animal" means a mammal. Preferred animals are include humans, rats, mice, guinea pigs, rabbits, monkeys, cats, dogs, cows, horses, pigs, and sheep.

15 The phrases "therapeutically effective amount" and "effective amount" are synonymous unless otherwise indicated, and mean an amount of a compound of the present invention that is sufficient to improve the condition, disease, or disorder being treated. Determination of a therapeutically effective amount, as well as other factors related to effective administration of a compound of the present invention to a patient in need of treatment, including dosage forms, routes of administration, and frequency of dosing, may depend upon the particulars of
20 the condition that is encountered, including the patient and condition being treated, the severity of the condition in a particular patient, the particular compound being employed, the particular route of administration being employed, the frequency of dosing, and the particular formulation being employed. Determination of a therapeutically effective treatment regimen for a patient is
25 within the level of ordinary skill in the medical or veterinarian arts. In clinical use, an effective amount may be the amount that is recommended by the U.S. Food and Drug Administration, or an equivalent foreign agency.

30 The phrase "admixed" or "in admixture" means the ingredients so mixed comprise either a heterogeneous or homogeneous mixture. Preferred is a homogeneous mixture.

The phrases "pharmaceutical preparation" and "preparation" are synonymous unless otherwise indicated, and include the formulation of the active compound with encapsulating material as a carrier providing a capsule in which

-24-

the active component, with or without other carriers, is surrounded by a carrier, which is thus in association with it. Similarly, cachets and lozenges are included. Pharmaceutical preparations are fully described below.

5 The phrase "anticancer effective amount" means an amount of invention compound, or a pharmaceutically acceptable salt thereof, sufficient to inhibit, halt, or cause regression of the cancer being treated in a particular patient or patient population. For example in humans or other mammals, an anticancer effective amount can be determined experimentally in a laboratory or clinical setting, or may be the amount required by the guidelines of the United States Food and Drug
10 Administration, or equivalent foreign agency, for the particular cancer and patient being treated.

 The phrase "MMP-13 inhibiting amount" means an amount of invention compound, or a pharmaceutically acceptable salt thereof, sufficient to inhibit an enzyme matrix metalloproteinase-13, including a truncated form thereof,
15 including a catalytic domain thereof, in a particular animal or animal population. For example in a human or other mammal, an MMP-13 inhibiting amount can be determined experimentally in a laboratory or clinical setting, or may be the amount required by the guidelines of the United States Food and Drug Administration, or equivalent foreign agency, for the particular MMP-13 enzyme
20 and patient being treated.

 It should be appreciated that the matrix metalloproteinases include the following enzymes:

- MMP-1, also known as interstitial collagenase, collagenase-1, or
 fibroblast-type collagenase;
- 25 MMP-2, also known as gelatinase A or 72 kDa Type IV collagenase;
- MMP-3, also known as stromelysin or stromelysin-1;
- MMP-7, also known as matrilysin or PUMP-1;
- MMP-8, also known as collagenase-2, neutrophil collagenase, or
 polymorphonuclear-type ("PMN-type") collagenase;
- 30 MMP-9, also known as gelatinase B or 92 kDa Type IV collagenase;
- MMP-10, also known as stromelysin-2;
- MMP-11, also known as stromelysin-3;
- MMP-12, also known as metalloelastase;

-25-

MMP-13, also known as collagenase-3;

MMP-14, also known as membrane-type ("MT") 1-MMP or MT1-MMP;

MMP-15, also known as MT2-MMP;

MMP-16, also known as MT3-MMP;

5 MMP-17, also known as MT4-MMP;

MMP-18; and

MMP-19.

Other MMPs are known, including MMP-26, which is also known as
matrilysin-2.

10 One aspect of the present invention is a compound of Formula I, or a
pharmaceutically acceptable salt thereof, that is a selective inhibitor of the enzyme
MMP-13. A selective inhibitor of MMP-13, as used in the present invention, is a
compound that is ≥ 5 times more potent *in vitro* versus MMP-13 than versus at
least one other matrix metalloproteinase enzyme such as, for example, MMP-1,
15 MMP-2, MMP-3, MMP-7, MMP-8, MMP-9, or MMP-14, or versus tumor
necrosis factor alpha convertase ("TACE"). A preferred aspect of the present
invention is a compound that is a selective inhibitor of MMP-13 versus MMP-1.

Another aspect of the present invention is a compound of Formula I, or a
pharmaceutically acceptable salt thereof, that is a selective inhibitor of MMP-13
20 versus 2, 3, 4, 5, 6, or 7 other MMP enzymes, or versus TACE and 1, 2, 3, 4, 5, 6,
or 7 other MMP enzymes. O

Another aspect of the present invention is a compound of Formula I, or a
pharmaceutically acceptable salt thereof, that is ≥ 10 times, ≥ 20 times, ≥ 50 times,
 ≥ 100 times, or ≥ 1000 times more potent versus MMP-13 than versus at least one
25 of any other MMP enzyme or TACE.

It should be appreciated that determination of proper dosage forms, dosage
amounts, and routes of administration, is within the level of ordinary skill in the
pharmaceutical and medical arts, and is described below.

The term "IC₅₀" means the concentration of test compound required to
30 inhibit activity of a biological target, such as a receptor or enzyme, by 50%.

The phrase "catalytic domain" means the domain containing a catalytic
zinc cation of the MMP enzyme, wherein the MMP enzyme contains 2 or more

-26-

domains. A catalytic domain includes truncated forms thereof that retain at least some of the catalytic activity of MMP-13 or MMP-13CD. For example, the collagenases, of which MMP-13 is a member, have been reported to contain a signal peptide domain, a propeptide domain, a catalytic domain, and a hemopexin-like domain (Ye Qi-Zhuang, Hupe D., Johnson L., *Current Medicinal Chemistry*, 1996;3:407-418).

The phrase "a method for inhibiting MMP-13" includes methods of inhibiting full length MMP-13, truncated forms thereof that retain catalytic activity, including forms that contain the catalytic domain of MMP-13, as well as the catalytic domain of MMP-13 alone, and truncated forms of the catalytic domain of MMP-13 that retain at least some catalytic activity.

It should be appreciated that it has been shown previously (Ye Qi-Zhuang, et al., 1996, supra) that inhibitor activity against a catalytic domain of an MMP is predictive of the inhibitor activity against the respective full-length enzyme.

The compounds to be used in the present invention can exist in unsolvated forms as well as solvated forms, including hydrated forms. In general, the solvated forms, including hydrated forms, are equivalent to unsolvated forms and are intended to be encompassed within the scope of the present invention. Some of the invention compounds may have one or more chiral centers, and as such can exist as individual enantiomers and mixtures. This invention contemplates all racemic mixtures, pure enantiomers, as well as geometric and positional isomers.

The compounds of Formulas I and II are capable of further forming both pharmaceutically acceptable salts, including but not limited to acid addition and/or base salts, solvates, and N-oxides of a compound of Formulas I and II. This invention also provides pharmaceutical formulations comprising a compound of Formulas I and II together with a pharmaceutically acceptable carrier, diluent, or excipient therefor. All of these forms can be used in the method of the present invention.

Pharmaceutically acceptable acid addition salts of the compounds of Formulas I and II include salts derived from inorganic acids such as hydrochloric, nitric, phosphoric, sulfuric, hydrobromic, hydriodic, phosphorus, and the like, as well as the salts derived from organic acids, such as aliphatic mono- and dicarboxylic acids, phenyl-substituted alkanoic acids, hydroxy alkanoic acids,

-27-

alkanedioic acids, aromatic acids, aliphatic and aromatic sulfonic acids, etc. Such salts thus include sulfate, pyrosulfate, bisulfate, sulfite, bisulfite, nitrate, phosphate, monohydrogenphosphate, dihydrogenphosphate, metaphosphate, pyrophosphate, chloride, bromide, iodide, acetate, propionate, caprylate, isobutyrate, oxalate, malonate, succinate, suberate, sebacate, fumarate, maleate, mandelate, benzoate, chlorobenzoate, methylbenzoate, dinitrobenzoate, phthalate, benzenesulfonate, toluenesulfonate, phenylacetate, citrate, lactate, maleate, tartrate, methanesulfonate, and the like. Also contemplated are the salts of amino acids such as arginate, gluconate, galacturonate, and the like; see, for example, Berge et al., "Pharmaceutical Salts," *J. of Pharmaceutical Science*, 1977;66:1-19.

The acid addition salts of the basic compounds are prepared by contacting the free-base form with a sufficient amount of the desired acid to produce the salt in the conventional manner. The free-base form may be regenerated by contacting the salt form with a base and isolating the free base in the conventional manner. The free-base forms differ from their respective salt forms somewhat in certain physical properties such as solubility in polar solvents, but otherwise the salts are equivalent to their respective free base for purposes of the present invention.

Pharmaceutically acceptable base addition salts (for example when carboxylic acid groups are present) are formed with metals or amines, such as alkali and alkaline earth metal hydroxides, or of organic amines. Examples of metals used as cations are sodium, potassium, magnesium, calcium, and the like. Examples of suitable amines are N,N'-dibenzylethylenediamine, chlorprocaine, choline, diethanolamine, ethylenediamine, N-methylglucamine, and procaine; see, for example, Berge et al., *supra*.

The base addition salts of acidic compounds are prepared by contacting the free acid form with a sufficient amount of the desired base to produce the salt in the conventional manner. The free acid form may be regenerated by contacting the salt form with an acid and isolating the free acid in a conventional manner. The free acid forms differ from their respective salt forms somewhat in certain physical properties such as solubility in polar solvents, but otherwise the salts are equivalent to their respective free acid for purposes of the present invention.

-28-

The compounds of the present invention can be formulated and administered in a wide variety of oral and parenteral dosage forms, including parenteral, oral, transdermal, and rectal administration. All that is required is that an MMP inhibitor be administered to a mammal suffering from a disease in an effective amount, which is that amount required to cause an improvement in the disease and/or the symptoms associated with such disease. It will be recognized by those skilled in the art that the dosage forms provided herein may comprise as the active component, a compound of Formula I or a corresponding pharmaceutically acceptable salt or solvate of a compound of Formula I, admixed with any conventional excipient, diluent, or carrier.

A compound of Formula I, or a pharmaceutically acceptable salt thereof, may be prepared by one of ordinary skill in the art of organic chemistry by procedures found in the chemical literature such as, for example, *Reagents for Organic Synthesis*, by Fieser and Fieser, John Wiley & Sons, Inc., New York, 2000; *Comprehensive Organic Transformations*, by Richard C. Larock, VCH Publishers, Inc., New York, 1989; the series *Compendium of Organic Synthetic Methods* (1989) by Wiley-Interscience; the text *Advanced Organic Chemistry*, 5th edition, by Jerry March, Wiley-Interscience, New York (2001); or the *Handbook of Heterocyclic Chemistry*, by Alan R. Katritzky, Pergamon Press Ltd., London, (1985), to name a few. Alternatively, a skilled artisan may find methods useful for preparing the invention compounds in the chemical literature by searching widely available databases such as, for example, those available from the *Chemical Abstracts Service*, Columbus, Ohio, or *MDL Information Systems GmbH* (formerly *Beilstein Information Systems GmbH*), Frankfurt, Germany.

Preparations of the compounds of the present invention may use starting materials, reagents, solvents, and catalysts that may be purchased from commercial sources or they may be readily prepared by adapting procedures in the references or resources cited above. Commercial sources of starting materials, reagents, solvents, and catalysts useful in preparing invention compounds include, for example, *The Aldrich Chemical Company*, and other subsidiaries of Sigma-Aldrich Corporation, St. Louis, Missouri, *BACHEM*, BACHEM A.G., Switzerland, or *Lancaster Synthesis Ltd.*, United Kingdom.

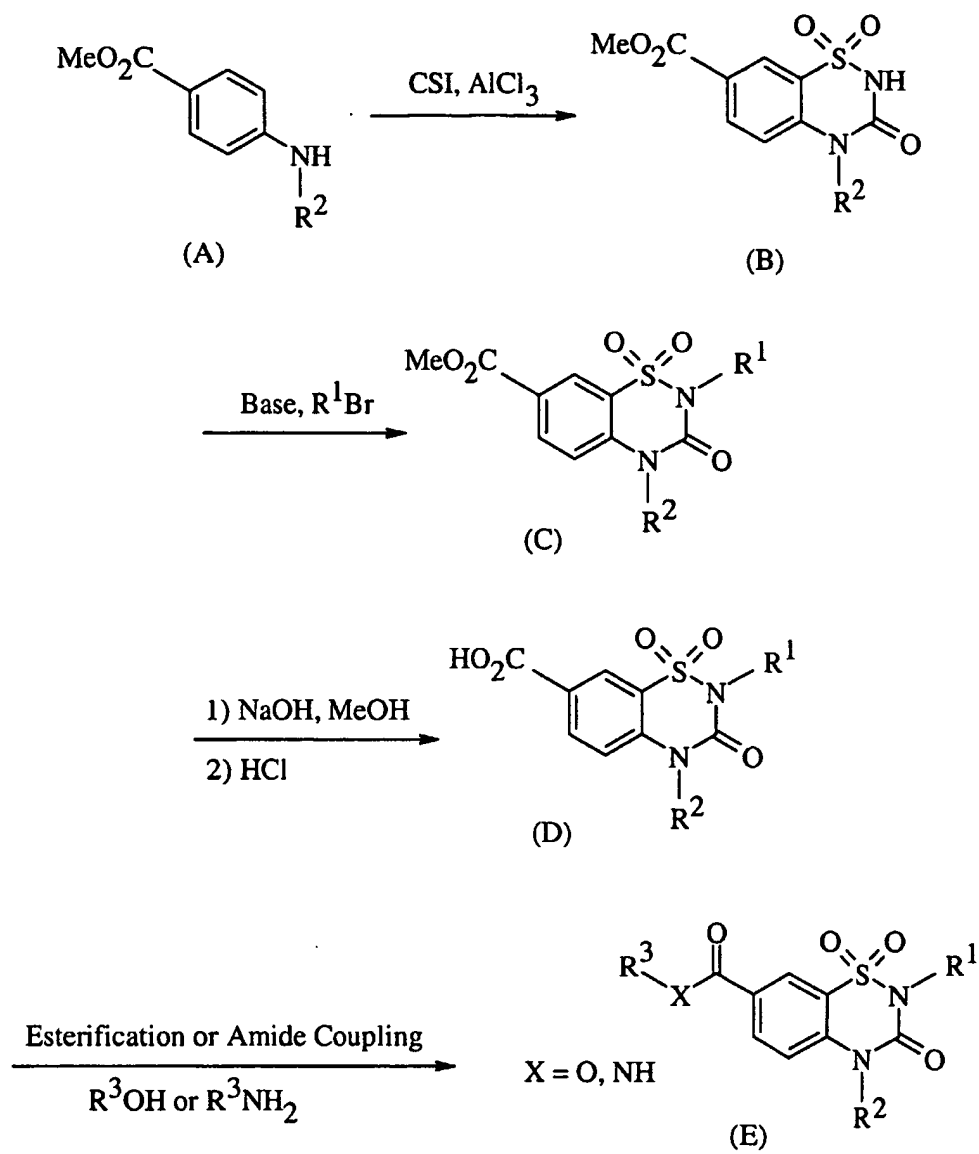
-29-

Reagents for Organic Synthesis, by Fieser and Fieser, John Wiley & Sons, Inc., New York, 2000; *Comprehensive Organic Transformations*, by Richard C. Larock, VCH Publishers, Inc., New York, 1989; the series *Compendium of Organic Synthetic Methods* (1989) by Wiley-Interscience; the text *Advanced Organic Chemistry*, 5th edition, by Jerry March, Wiley-Interscience, New York (2001); and the *Handbook of Heterocyclic Chemistry*, by Alan R. Katritzky, Pergamon Press Ltd., London, (1985) are hereby incorporated by reference.

The invention compounds are prepared by methods well-known to those skilled in the art of organic chemistry. The compounds of Formula I are prepared utilizing commercially available starting materials, or reactants that are readily prepared by standard organic synthetic techniques. A typical synthesis of the invention compounds of Formula I is shown in Scheme 1 below. The first step in Scheme 1 comprises reacting a substituted (R^2) anthranilate of formula (A) with N-chlorosulfonyl isocyanate (CSI) followed by an appropriate Lewis acid such as aluminum trichloride in the manner described by Girard Y et al., (*J. Chem. Soc. Perkins I*, 1979:1043-1047). The resulting 1,2,4-benzothiadiazone carboxylate (B) can then be alkylated in the 3 position to give the compound (C) (for example by reaction with a common alkylating agent such as an alkyl halide, generally in the presence of a base such as triethylamine or pyridine). Simple hydrolysis of the ester under standard conditions (eg, alkaline conditions) affords the carboxylic acid (D). This acid can then be further reacted with alcohols or amines to provide the desired ester or carboxylic amide (E) using standard coupling conditions known to those skilled in the art (such as 1,3-dicyclohexylcarbodiimide (DCC) activation, in situ acid halide formation, 1,1-carbonyldiimidazole (CDI) activation, etc.). The invention compounds can be isolated and purified by standard methods such as crystallization (from solvents such as alcohols, alkylesters, haloalkanes, alkanes) and chromatography over solid supports such as silica gel (eluting with solvents such as dichloromethane, ethyl acetate, methanol). Optically active compounds can be isolated by standard methods, for example fractional crystallization, chiral synthesis, and classical resolution.

-30-

Scheme 1

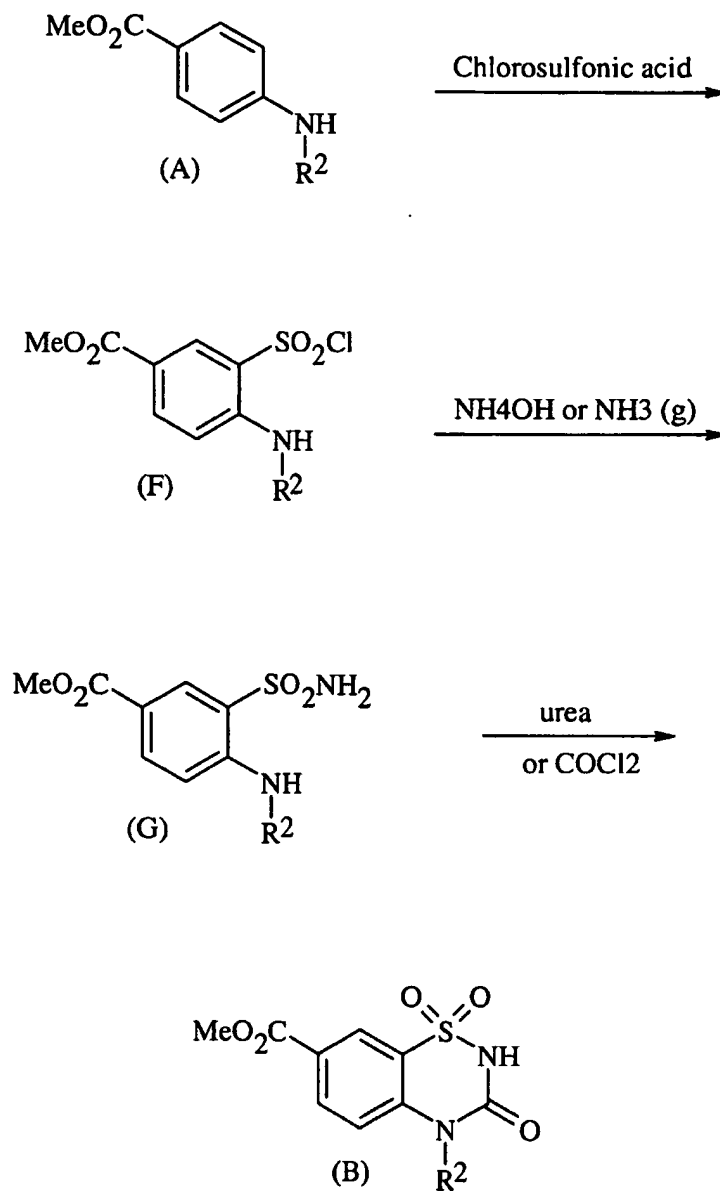


-31-

An alternative synthesis of the benzothiadiazines of the invention is given in Scheme 2. In this case, a substituted (R^2) anthranilate of formula (A) is reacted with excess chlorosulfonic acid to give the sulfonyl chloride (F). This sulfonyl chloride is readily converted to the corresponding sulfonamide (G) by reaction
5 with saturated ammonium hydroxide or liquid ammonia. Reaction of this sulfonamide with urea (or a similar $C=O$ synthon such as phosgene or triphosgene) affords the desired 1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine ring system (B) which can be further elaborated to the compounds of the present invention as demonstrated in Scheme 1.

-32-

Scheme 2



-33-

During the synthesis of some of the invention compounds, it may be desirable to protect reactive functional groups such as hydroxy, amino, and carboxylic groups, so as to avoid unwanted side reactions. The use of protecting groups in synthetic organic chemistry is well-established and is fully described by
5 Greene and Wuts in "Protecting Groups in Organic Synthesis" (John Wiley & Son Press, 3rd ed). Examples of common amino protecting groups include acyl groups such as formyl and acetyl, and arylalkyl groups such as benzyl. Typical hydroxy protecting groups include ether forming groups such as methyl and ethyl, and acyl groups such as acetyl and *tert*-butoxycarbonyl (tBOC). Carboxylic acids generally
10 are protected as esters, for example 2,2,2-trichloroethyl and benzyl. These protecting groups are readily cleaved by standard methods when desired.

Sulfoxides and sulfones of Formula I, wherein n is 1 or 2, are prepared by oxidation of the corresponding sulfides with one or two equivalents of an oxidizing agent such as peracetic acid or meta-chloroperbenzoic acid.

15 The following detailed examples further illustrate the synthesis of typical invention compounds of Formula I. In the examples where the compound of the example is characterized by elemental analysis of, for illustration, carbon, hydrogen, and nitrogen, the term "C,H,N" means the percents found of carbon, hydrogen, and nitrogen were within $\pm 0.4\%$ of their respective theoretical values
20 for the molecular formula recited. The examples are representative only and are not to be construed as limiting the invention in any respect.

All references cited herein are incorporated by reference.

EXAMPLE 1

**Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-
25 1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid benzyl ester**

**Step 1: Synthesis of 4-Methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-
1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid methyl ester**

Methyl-4-methylaminobenzoate (4.96 g, 30 mmoles) was dissolved in 20 mL of nitromethane, and this solution was added dropwise to a solution of
30 3.13 mL *N*-chlorosulfonyl isocyanate in 5 mL of nitromethane at 0°C. The resulting solution was stirred for 15 minutes and then 5.2 g (39 mmoles) of solid

-34-

aluminum trichloride was added. The resulting mixture was heated to reflux for 1 hour. The reaction mixture was concentrated to dryness in vacuo, and the residue was diluted by carefully adding 30 mL of ice water. The resulting yellowish solid was collected by filtration and recrystallized from 30 mL of ethyl acetate to give 3.95 g (49%) of the title compound as an off-white powder.

$^1\text{H-NMR}$ (CDCl_3): δ 8.47 (s, 1H), 8.22 (d, 1H), 7.24 (d, 2H), 3.89 (s, 3H), and 3.46 (s, 3H) ppm. MS: $\text{M}^+ + 1 = 271.1$ Da

Step 2: Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid methyl ester

4-Methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid methyl ester (1.00 g, 3.7 mmol) was mixed with benzyl bromide (0.66 mL, 5.6 mmol) in 25 mL of acetonitrile containing 0.83 mL (5.6 mmol) of 1,8-diazabicyclo[5.4.0]undec-7-ene. The reaction mixture was stirred for 16 hours at room temperature. The mixture was concentrated to 5 mL by evaporation of solvents in vacuo, and the oil was partitioned between 25 mL of 1 M HCl and 25 mL of ethyl acetate. The organic layer was separated, dried (magnesium sulfate), and concentrated to give the product as an off-white solid. The white solid was triturated 3 times with 25 mL portions of hexanes to give 0.98 g (73%) of the title compound. $^1\text{H-NMR}$ (CDCl_3): δ 8.58 (s, 1H), 8.30 (d, 1H), 7.44 (d, 2H), 7.27 (m, 4H), 5.07 (s, 2H), 3.96 (s, 3H), and 3.53 (s, 3H) ppm. Anal. ($\text{C}_{17}\text{H}_{16}\text{N}_2\text{O}_5\text{S}_1$) C, H, N. MS: $\text{M}^+ + 1 = 361.0$ Da

Step 3: Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid.

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid methyl ester (0.87 g, 2.4 mmol) was mixed with 3 mL of 1 M NaOH in 25 mL of methanol. The reaction mixture was stirred for 60 hours and then concentrated to dryness in vacuo. The residue was partitioned between 20 mL of water and 30 mL dichloromethane. The aqueous layer was acidified with conc. HCl, and the resulting suspension was collected by filtration and dried on the vacuum filter to give 0.60 g (73%) of the title compound as an

-35-

off-white solid. $^1\text{H-NMR}$ (CDCl_3): δ 8.67 (s, 1H), 8.37 (d, 1H), 7.46 (d, 2H), 7.30 (m, 4H), 5.08 (s, 2H), and 3.56 (s, 3H) ppm. MS: $\text{M}^+ + 1 = 347.1$ Da

Step 4: Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid benzyl ester

5 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]-thiadiazine-7-carboxylic acid (0.25 g, 0.7 mmol) was suspended in 20 mL of dichloromethane. Oxalyl chloride (0.076 mL, 0.87 mmol) was added to the suspension, followed by 2 drops of DMF. The resulting effervescent mixture was stirred for 3 hours. The resulting clear solution was then concentrated to dryness to give an oil. Benzyl alcohol (0.082 mL, 0.79 mmol) was added to the oil, and the mixture was dissolved in 5 mL of pyridine. 40 mL of water was added, and the resulting milky mixture was stirred for 2 hours. The suspension was filtered and the solid filter cake was chromatographed on silica (eluting with 30% ethyl acetate in hexanes) to give 0.10 g (33%) of the title compound as a white solid. $^1\text{H-NMR}$ (15 CDCl_3): δ 8.59 (s, 1H), 8.33 (d, 1H), 7.36 (m, 8H), 5.39 (s, 2H), 5.07 (s, 2H), and 3.53 (s, 3H) ppm. Anal. ($\text{C}_{23}\text{H}_{20}\text{N}_2\text{O}_5\text{S}_1$) C,H,N. MS: $\text{M}^+ + 1 = 437.1$ Da

EXAMPLE 2

Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide

20 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid (0.20 g, 0.6 mmol, from Example 1, Step 3) was suspended in 20 mL of dichloromethane. Oxalyl chloride (0.06 mL, 0.7 mmol) was added, followed by 2 drops of DMF. The resulting effervescent mixture was stirred for 3 hours. The resulting clear solution was then concentrated to dryness. The residue was redissolved in 15 mL dichloromethane and 0.063 mL of benzylamine (0.6 mmol) was added, followed by 0.16 mL (1.2 mmol) of triethylamine. This mixture was stirred for 16 hours at room temperature, and then partitioned between 1 M HCl and dichloromethane. The organic layer was separated, dried (magnesium sulfate), and concentrated to give

-36-

an off-white solid. Chromatography of the off-white solid on silica gel gave 0.14 g of the title compound as a white solid. $^1\text{H-NMR}$ (CDCl_3); δ 8.23 (s, 1H), 8.17 (d, 1H), 7.35 (m, 1H), 6.47 (bs, 1H), 5.05 (s, 2H), 4.65 (d, 2H), and 3.52 (s, 3H) ppm. Anal. ($\text{C}_{23}\text{H}_{21}\text{N}_3\text{O}_4\text{S}_1 \cdot 0.25\text{H}_2\text{O}$) C,H,N. MS: $\text{M}^+ + 1 = 436.1$ Da

5

EXAMPLE 3

Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide

The procedure of Example 2 was followed, except that 4-(aminomethyl)pyridine was substituted for benzylamine, to provide the title compound.

10 $^1\text{H-NMR}$ (CDCl_3): δ 8.59 (d, 2H), 8.29 (s, 1H), 8.21 (d, 1H), 7.42 (d, 2H), 7.30 (m, 6H), 5.06 (s, 2H), 4.67 (d, 2H), and 3.54 (s, 3H) ppm. Anal. ($\text{C}_{22}\text{H}_{20}\text{N}_4\text{O}_4\text{S}_1 \cdot 0.5\text{C}_4\text{H}_8\text{O}_2$) C,H,N. MS: $\text{M}^+ + 1 = 437.1$ Da

EXAMPLE 4

15 **Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid (1H-indol-5-ylmethyl)-amide**

The procedure of Example 2 was followed except that 5-(methylamino)indole was substituted for benzylamine, to provide the title compound. $^1\text{H-NMR}$ (CDCl_3); δ 9.43 (bs, 1H), 8.45 (s, 1H), 8.18 (m, 2H), 7.52 (s, 1H), 7.19 (m, 9H), 6.37 (s, 1H), 4.94 (s, 2H), 4.60 (d, 2H), and 3.41 (s, 20 3H) ppm. Anal. ($\text{C}_{25}\text{H}_{22}\text{N}_4\text{O}_4\text{S}_1 \cdot 0.33\text{H}_2\text{O}$) C,H,N. MS: $\text{M}^+ + 1 = 475.2$ Da

EXAMPLE 5

Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

25 The procedure of Example 2 was followed except that 4-methoxybenzylamine was substituted for benzylamine, to provide the title compound. $^1\text{H-NMR}$ (CDCl_3); δ 8.21 (s, 1H), 8.14 (d, 1H), 7.40 (d, 2H), 7.27 (m,

-37-

6H), 6.89 (d, 2H), 6.50 (bs, 1H), 5.04 (s, 2H), 4.57 (d, 2H), 3.80 (s, 3H), and 3.51 (s, 3H) ppm. Anal. (C₂₄H₂₃N₃O₅S₁) C,H,N. MS: M⁺ + 1 = 466.2 Da

EXAMPLE 6

Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ 6-

5 **benzo[1,2,4]thiadiazine-7-carboxylic acid 4-(2-*tert*-butylsulfamoyl-ethyl)-benzylamide**

The procedure of Example 2 was followed except that 2-(4-Aminomethyl-phenyl)-ethanesulfonic acid *t*-butyl amide was substituted for benzylamine, to provide the title compound. ¹H-NMR (CDCl₃); δ 8.20 (m, 2H), 7.30 (m, 12H),
10 5.05 (s, 2H), 4.60 (d, 2H), 4.30 (t, 2H), 4.07 (t, 2H), 3.24 (s, 3H), and 1.35 (s, 9H) ppm. Anal. (C₂₉H₃₄N₄O₆S₂ · 0.75C₄H₁₀O · 0.2CH₂Cl₂) C,H,N.

MS: M⁺ - 1 = 598.1 Da

EXAMPLE 7

Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ 6-

15 **benzo[1,2,4]thiadiazine-7-carboxylic acid (1H-indol-2-ylmethyl)-amide**

The procedure of Example 2 was followed except that *C*-indol-2-yl-methylamine was substituted for benzylamine, to provide the title compound.

¹H-NMR (CDCl₃); δ 8.95 (s, 1H), 8.25 (s, 1H), 8.09 (d, 1H), 7.54 (d, 2H), 7.40 (d, 2H), 7.24 (m, 6H), 7.07 (t, 1H), 6.95 (t, 1H), 6.38 (s, 1H), 5.04 (s, 2H), 4.70 (d,
20 2H), and 3.48 (s, 3H) ppm. Anal. (C₂₅H₂₂N₄O₄S₁ · 0.5C₄H₁₀O · 0.5H₂O)

C,H,N. MS: M⁺ + 1 = 475.1 Da

EXAMPLE 8

Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ 6-

benzo[1,2,4]thiadiazine-7-carboxylic acid 4-(2-sulfamoyl-ethyl)-benzylamide

25 **2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ 6-**

benzo[1,2,4]thiadiazine-7-carboxylic acid 4-(2-*tert*-butylsulfamoyl-ethyl)-

benzylamide (0.11 g, Example 6) was dissolved in 5 mL of trifluoroacetic acid at room temperature. This solution was stirred for 1 hour, concentrated in vacuo, and

-38-

quenched with water. The mixture was extracted with ethyl acetate. The ethyl acetate extracts were dried (magnesium sulfate), filtered, and concentrated to give a white foam. Triturated with diethyl ether to give the title compound as a gray solid. $^1\text{H-NMR}$ (CDCl_3); δ 8.20 (m, 2H), 7.28 (m, 12H), 5.05 (s, 2H), 4.64 (d, 2H), 4.29 (t, 2H), 4.06 (t, 2H), 3.23 (s, 3H), and 3.07 (bs, 2H) ppm. Anal. ($\text{C}_{25}\text{H}_{26}\text{N}_4\text{O}_6\text{S}_2 \cdot 0.5\text{C}_4\text{H}_{10}\text{O} \cdot 1.0\text{H}_2\text{O}$) C,H,N. MS: $\text{M}^+ - 1 = 543.0$ Da

EXAMPLE 9

Synthesis of 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide

Step 1: Synthesis of 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -benzo[1,2,4]thiadiazine-7-carboxylic acid methyl ester.

The procedure of Example 1, Step 2 was followed except that 4-methanesulfonyl-benzyl chloride was substituted for benzyl bromide, to provide the title compound. $^1\text{H-NMR}$ (CDCl_3); δ 8.58 (s, 1H), 8.34 (dd, 1H), 7.89 (d, 2H), 7.64 (d, 2H), 7.32 (d, 1H), 5.12 (s, 2H), 3.97 (s, 3H), 3.56 (s, 3H) and 3.02 (s, 3H) ppm. MS: $\text{M}^+ + 1 = 439.0$ Da

Step 2: Synthesis of 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -benzo[1,2,4]thiadiazine-7-carboxylic acid.

2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -benzo[1,2,4]thiadiazine-7-carboxylic acid methyl ester was hydrolyzed according to the method described in Example 1, Step 3 to give the title compound. $^1\text{H-NMR}$ (CDCl_3); δ 8.49 (bs, 1H), 8.26 (d, 1H), 7.82 (d, 2H), 7.51 (d, 2H), 7.44 (d, 1H), 5.29 (s, 2H), 3.56 (s, 3H) and 3.02 (s, 3H) ppm.

MS: $\text{M}^+ - 1 = 423.0$ Da

Step 3: Synthesis of 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide

2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -benzo[1,2,4]thiadiazine-7-carboxylic acid was coupled with benzyl amine according to the procedure of Example 2 to give the title compound. $^1\text{H-NMR}$

-39-

(CDCl₃); δ 8.19 (s, 1H), 8.01 (d, 1H), 7.74 (d, 2H), 7.45 (d, 2H), 7.34 (m, 6H), 6.67 (bs, 1H), 4.62 (t, 2H), 3.76 (bs, 2H), 3.22 (s, 3H) and 2.98 (s, 3H) ppm. Anal. (C₂₄H₂₃N₃O₆S₂ · 0.5C₄H₁₀O · 0.66H₂O) C,H,N. MS: M⁺ + 1 = 514.1 Da

EXAMPLE 10

5 **Synthesis of 4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1 λ 6-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester**

The procedure of Example 9 was followed except that in Step 2, *t*-butyl-*p*-bromomethylbenzoate was substituted for 4-methanesulfonyl-benzyl chloride, to provide the title compound. ¹H-NMR (CDCl₃); δ 8.23 (s, 1H), 8.18 (dd, 1H), 7.90 (d, 2H), 7.44 (d, 2H), 7.32 (m, 6H), 6.53 (t, 1H), 5.07 (s, 2H), 4.65 (d, 2H), 3.52 (s, 3H), and 1.54 (s, 9H) ppm. Anal. (C₂₈H₂₉N₃O₆S₁) C,H,N.
10
MS: M⁺ + 1 = 536.2 Da

EXAMPLE 11

15 **Synthesis of 4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1 λ 6-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid**

4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1 λ 6-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester (0.81 g, Example 10) was dissolved in 4 mL of trifluoroacetic acid. Stirred for 1 hour, concentrated in vacuo, and triturated the residue with diethyl ether to provide the title compound (0.65 g, 90%) as a white solid. ¹H-NMR (CDCl₃); δ 8.49 (s, 1H), 8.27 (dd, 1H), 8.19 (t, 1H), 7.92 (d, 2H), 7.40 (d, 2H), 7.28 (m, 6H), 5.04 (s, 2H), 4.58 (d, 2H), and 3.48 (s, 3H) ppm. Anal. (C₂₄H₂₁N₃O₆S₁ · 0.25C₄H₁₀O · 0.66H₂O) C,H,N. MS: M⁺ + 1 = 480.1 Da
20

-40-

EXAMPLE 12

Synthesis of 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1 λ^6 -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid *tert*-butyl ester

5 The procedure of Example 9 was followed except that in Step 2, *t*-butyl-*p*-bromomethylbenzoate was substituted for 4-methanesulfonyl-benzyl chloride; and in Step 3, 4-methoxybenzylamine was substituted for benzyl amine, to provide the title compound. ¹H-NMR (CDCl₃); δ 8.21 (s, 1H), 8.17 (dd, 1H), 7.90 (d, 2H), 7.43 (d, 2H), 7.27 (m, 3H), 6.89 (d, 2H), 6.48 (t, 1H), 5.07 (s, 2H), 4.57 (d, 2H),
10 3.80 (s, 3H), 3.51 (s, 3H), and 1.54 (s, 9H) ppm. Anal. (C₂₉H₃₁N₃O₇S₁) C,H,N.
MS: M⁺ + 1 = 566.2 Da

EXAMPLE 13

Synthesis of 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1 λ^6 -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid

15 The procedure of Example 11 was followed except that 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1 λ^6 -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid *tert*-butyl ester (Example 12) was substituted for 4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1 λ^6 -benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester (Example 10) to
20 provide the title compound. ¹H-NMR (CDCl₃); δ 8.45 (s, 1H), 8.22 (m, 2H), 7.89 (d, 2H), 7.37 (d, 2H), 7.23 (m, 3H), 6.79 (d, 2H), 5.00 (s, 2H), 4.47 (d, 2H), 3.71 (s, 3H), and 3.45 (s, 3H) ppm. Anal. (C₂₅H₂₃N₃O₇S₁ · 0.33H₂O) C,H,N.
MS: M⁺ + 1 = 510.1 Da

EXAMPLE 14

25 **Synthesis of 2-(4-Carbamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ^6 -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide**

 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1 λ^6 -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid (0.1 g, Example 13) was

-41-

mixed in 10 mL dichloromethane with 0.03 mL of oxalyl chloride. The resulting effervescent solution was stirred for 1 hour and then concentrated in vacuo. The residue was dissolved in 10 mL dichloromethane and added to a mixture of 5 mL ammonium hydroxide in 20 mL diethyl ether. This mixture was stirred for 1 hour and then concentrated in vacuo. The resulting solid was washed with water to give 0.04 g of the title compound as a gray solid. $^1\text{H-NMR}$ (CDCl_3); δ 8.45 (s, 1H), 8.25 (d, 1H), 8.02 (t, 1H), 7.72 (d, 2H), 7.43 (d, 2H), 7.25 (s, 3H), 6.82 (d, 2H), 5.03 (s, 2H), 4.50 (d, 2H), 3.74 (s, 3H), 3.48 (s, 3H), and 2.56 (bs, 2H) ppm. Anal. ($\text{C}_{25}\text{H}_{24}\text{N}_4\text{O}_6\text{S}_1 \cdot 0.2\text{C}_4\text{H}_{10}\text{O} \cdot 0.25\text{H}_2\text{O}$) C,H,N. MS: $\text{M}^+ + 1 = 509.1$ Da

10

EXAMPLE 15

Synthesis of 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

The procedure of Example 9 was followed except that in Step 3, 4-methoxybenzylamine was substituted for benzylamine, to provide the title compound. $^1\text{H-NMR}$ (CDCl_3); δ 8.17 (bs, 1H), 8.00 (d, 1H), 7.77 (d, 2H), 7.47 (d, 2H), 7.37 (d, 1H), 7.28 (m, 3H), 6.89 (d, 2H), 6.47 (bt, 1H), 4.56 (m, 2H), 4.36 (m, 1H), 4.13 (m, 1H), 3.80 (s, 3H), 3.24 (s, 3H), and 3.01 (s, 3H) ppm. Anal. ($\text{C}_{25}\text{H}_{25}\text{N}_3\text{O}_7\text{S}_2 \cdot 0.5\text{C}_4\text{H}_{10}\text{O} \cdot 1.5\text{H}_2\text{O}$) C,H,N. MS: $\text{M}^+ + 1 = 544.1$ Da

20

EXAMPLE 16

Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro -1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-fluoro-benzylamide

The procedure of Example 2 was followed except that 4-fluorobenzylamine was substituted for benzylamine, to provide the title compound. $^1\text{H-NMR}$ (CDCl_3); δ 8.21 (s, 1H), 8.15 (dd, 1H), 7.40 (d, 2H), 7.29 (m, 6H), 7.04 (t, 2H), 6.57 (t, 1H), 5.04 (s, 2H), 4.60 (d, 2H), and 3.51 (s, 3H) ppm. Anal. ($\text{C}_{23}\text{H}_{20}\text{N}_3\text{O}_4\text{S}_1\text{F}_1$) C,H,N. MS: $\text{M}^+ + 1 = 454.2$ Da

-42-

EXAMPLE 17

Synthesis of 4-Methyl-2-(4-nitro-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide**Step 1: Synthesis of 4-Methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-**

5 benzo[1,2,4]thiadiazine-7-carboxylic acid.

4-Methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid methyl ester (10.0 g, Example 1, Step 1) was dissolved in 200 mL of methanol with 75 mL of 1M NaOH. Stirred for 4 hours and concentrated in vacuo to remove the methanol. The residue was acidified with concentrated HCl,
10 filtered, and washed with water. Air dried on the vacuum filter to give 9.5 g of the title compound as a tan solid. ¹H-NMR (DMSO-*d*₆); δ 8.04 (s, 1H), 7.94 (dd, 1H), and 7.17 (d, 1H) ppm. MS: M⁺ - 1 = 255.1 Da

Step 2: Synthesis of 4-Methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide.

15 4-Methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (2.5 g, Step 1) was mixed with 4-methoxybenzylamine (1.32 g) and 1-hydroxybenzotriazole in 50 mL of N,N-dimethylformamide. 1-(3-Dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (1.87 g) was added, and the mixture was allowed to stir at room temperature for 16 hours. The
20 reaction was partitioned between 1M HCl and ethyl acetate. The organic layer was extracted with saturated sodium bicarbonate. The bicarbonate layer was then acidified and filtered. The white solid was washed with diethyl ether to give the title compound (2.26 g). ¹H-NMR (CDCl₃); δ 9.25 (t, 1H), 8.35 (d, 1H), 8.21 (dd, 1H), 7.57 (d, 1H), 7.22 (d, 2H), 6.86 (dd, 2H), 4.39 (d, 2H), 3.69 (s, 3H), 3.42
25 (s, 3H) and 2.47 (bs, 1H) ppm. MS: M⁺ + 1 = 376.1 Da

Step 3: Synthesis of 4-Methyl-2-(4-nitro-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide.

4-Methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide (1.0 g), and cesium carbonate (0.87 g)
30 were mixed in 50 mL of N,N-dimethylformamide. 4-Nitrobenzylbromide (0.58 g)

-43-

was added, and the resulting mixture was stirred for 16 hours at room temperature.

The reaction was diluted with 1M HCl and filtered to give a gummy solid.

Recrystallization from ethyl alcohol gave the title compound as a white solid

(0.77 g). ¹H-NMR (CDCl₃); δ 8.48 (s, 1H), 8.26 (d, 1H), 8.10 (m, 3H), 7.54 (d, 2H), 7.25 (m, 4H), 6.82 (t, 2H), 5.05 (s, 2H), 4.50 (d, 2H), 3.73 (d, 3H), and 3.48 (s, 3H) ppm. Anal. (C₂₄H₂₂N₄O₇S₁ · 1.0H₂O) C, H, N. MS: M⁺ + 1 = 511.2 Da

EXAMPLE 18

Synthesis of 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

The procedure of Example 17 was followed except that in Step 3, 4-methylsulfamoyl-benzyl bromide was substituted for 4-nitrobenzylbromide, to provide the title compound. ¹H-NMR (CDCl₃); δ 8.23 (d, 1H), 8.18 (d, 1H), 7.76 (d, 2H), 7.55 (d, 2H), 7.27 (m, 4H), 6.89 (d, 2H), 6.48 (bt, 1H), 5.08 (s, 2H), 4.58 (d, 2H), 3.80 (s, 3H), 3.54 (s, 3H), and 2.62 (d, 3H) ppm. Anal. (C₂₅H₂₆N₄O₇S₂ · 0.66C₂H₆O) C, H, N. MS: M⁺ + 1 = 559.1 Da

EXAMPLE 19

Synthesis of 4-Methyl-2-[4-(morpholine-4-sulfonyl)-benzyl]-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

The procedure of Example 17 was followed except that in Step 3, 4-(4-bromomethyl-benzenesulfonyl)-morpholine was substituted for 4-nitrobenzylbromide, to provide the title compound. ¹H-NMR (CDCl₃); δ 8.25 (s, 1H), 8.18 (d, 1H), 7.66 (d, 2H), 7.58 (d, 2H), 7.29 (m, 4H), 6.88 (d, 2H), 6.54 (bt, 1H), 5.08 (s, 2H), 4.57 (d, 2H), 3.80 (s, 3H), 3.69 (s, 4H), 3.54 (s, 3H), and 2.94 (s, 4H) ppm. Anal. (C₂₈H₃₀N₄O₈S₂ · 0.66H₂O) C, H, N. MS: M⁺ + 1 = 615.2 Da

-44-

EXAMPLE 20

Synthesis of 4-[7-(4-Fluorobenzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid methyl ester

The procedure of Example 17 was followed except that in Step 2,
5 4-fluorobenzyl amine was substituted for 4-methoxybenzylamine and in Step 3, methyl-4-bromomethylbenzoate was substituted for 4-nitrobenzylbromide, to provide the title compound. ¹H-NMR (CDCl₃); δ 8.24 (s, 1H), 8.19 (d, 1H), 7.94 (d, 2H), 7.45 (d, 2H), 7.29 (m, 3H), 7.03 (t, 2H), 6.71 (bt, 1H), 5.07 (s, 2H), 4.60 (d, 2H), 3.87 (s, 3H), and 3.52 (s, 3H) ppm. Anal. (C₂₅H₂₂N₃O₆S₁F₁) C, H, N.
10 MS: M⁺ + 1 = 512.2 Da

EXAMPLE 21

Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (2-methoxy-pyridin-4-ylmethyl)-amide

15 The procedure of Example 2 was followed except that C-(2-Methoxy-pyridin-4-yl)-methylamine was substituted for benzylamine, to provide the title compound. ¹H-NMR (CDCl₃); δ 8.26 (s, 1H), 8.18 (d, 1H), 8.13 (d, 1H), 7.43 (d, 2H), 7.30 (m, 4H), 6.84 (d, 1H), 6.69 (s, 2H), 5.06 (s, 2H), 4.61 (d, 2H), 3.93 (s, 3H), and 3.53 (s, 3H) ppm. Anal. (C₂₃H₂₂N₄O₅S₁) C, H, N.
20 MS: M⁺ + 1 = 467.2 Da

EXAMPLE 22

Synthesis of 4-Methyl-2-naphthalen-2-ylmethyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxybenzylamide

25 The procedure of Example 17 was followed except that in Step 3, 2-Bromomethyl-naphthalene was substituted for 4-nitrobenzylbromide, to provide the title compound. Anal. (C₂₈H₂₅N₃O₅S₁) C, H, N. MS: M⁺ + 1 = 516.3 Da

-45-

EXAMPLE 23

Synthesis of 2-Biphenyl-4-ylmethyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

The procedure of Example 17 was followed except that in Step 3,
5 4-Bromomethyl-biphenyl was substituted for 4-nitrobenzylbromide, to provide the title compound. Anal. (C₂₈H₂₅N₃O₅S₁) C,H,N. MS: M⁺ + 1 = 541.0 Da

EXAMPLE 24

Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (2,1,3-benzothiadiazol-5-ylmethyl)-amide

The procedure of Example 2 was followed except that
C-Benzo[1,2,5]thiadiazol-5-yl-methylamine hydrochloride was substituted for
benzylamine, to provide the title compound. ¹H-NMR (CDCl₃); δ 8.28 (s, 1H),
8.19 (dd, 1H), 7.98 (d, 1H), 7.92 (s, 1H), 7.58 (d, 1H), 7.41 (dd, 2H), 7.28 (m,
15 4H), 6.86 (bt, 1H), 5.05 (s, 2H), 4.83 (d, 2H), and 3.52 (s, 3H) ppm. Anal.
(C₂₃H₁₉N₅O₄S₂) C,H,N. MS: M⁺ + 1 = 494.2 Da

EXAMPLE 25

Synthesis of 4-[7-(4-Fluoro-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid

The procedure of Example 17 was followed except that in Step 2,
4-fluorobenzyl amine was substituted for 4-methoxybenzylamine and in Step 3,
4-bromomethyl-benzoic acid *tert*-butyl ester was substituted for
4-nitrobenzylbromide. The resulting *t*-butyl ester intermediate was hydrolyzed
following the procedure set forth in Example 11 to provide the title compound.
20 ¹H-NMR (CDCl₃); δ 8.54 (bt, 1H), 8.50 (s, 1H), 8.26 (dd, 1H), 7.89 (d, 2H), 7.38
(d, 2H), 7.26 (m, 3H), 6.94 (t, 2H), 5.01 (s, 2H), 4.50 (d, 2H), and 3.46 (s,
3H) ppm. Anal. (C₂₄H₂₀N₃O₆S₁F₁ · H₂O) C,H,N. MS: M⁺ + 1 = 498.2 Da

-46-

EXAMPLE 26

Synthesis of 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid 2-dimethylamino-ethyl ester hydrochloride

5 To a mixture of 0.39 (0.77 mmol) 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid (Example 13), 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride ("EDAC·HCl") 0.19 g (0.99 mmol), 1-hydroxybenzotriazole monohydrate ("HOBT") 0.13 g (0.99 mmol), in dimethylformamide (5 mL) is
10 added 2-N,N-dimethyl ethanolamine 0.089 g (0.99 mmol). The mixture is stirred overnight at room temperature before adding water (20 mL) and extracting with ethyl acetate (2 × 20 mL). Combined organic layers and wash with saturated aqueous NaCl, dry MgSO₄. Concentrate, dissolve in methanol and treat with 1 M HCl in ether. Concentrate, and slurry in hot ethyl acetate. Slurried product in hot
15 ethyl acetate to obtain 0.27 g of the title compound. Anal. (C₂₉H₃₂N₄O₇S₁·HCl·1.29 H₂O) C,H,N. MS: M⁺ + 1 = 581.4 Da

EXAMPLE 27

Synthesis of 4-Methyl-1,1,3-trioxo-2-[4-(piperidine-1-carbonyl)-benzyl]-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

20 Employing the procedure of Example 14 but substituting piperidine for ammonium hydroxide provided the title compound. Anal. (C₃₀H₃₂N₄O₆S₁) C,H,N. MS: M⁺ + 1 = 577.4 Da

-47-

EXAMPLE 28

Synthesis of 2-{4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1 λ ⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoylamino}-3-methyl-butyrac acid

5 **Step 1:** Synthesis of 2-{4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1 λ ⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoylamino}-3-methyl-butyrac acid *tert* butyl ester.

Employing the procedure of Example 26 but substituting *tert*-butyl valine HCl for 2-N,N-dimethyl ethanolamine provided the title compound.

10 MS: $M^+ + 1 = 665.4$ Da

Step 2: Synthesis of 2-{4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1 λ ⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoylamino}-3-methyl-butyrac acid.

To a solution of 0.18 g 2-{4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1 λ ⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoylamino}-3-methyl-butyrac acid *tert* butyl ester (0.27 mmol, Step 1) was added 10 mL 50% trifluoroacetic acid in CHCl_3 . The resulting mixture was stirred 2 hours at room temperature, then concentrated. Obtained 0.14 g of the title compound as a solid from EtOAc/hexane. Anal. ($\text{C}_{30}\text{H}_{32}\text{N}_4\text{O}_8\text{S}_1$) C,H,N. MS: $M^+ + 1 = 609.4$ Da

20

EXAMPLE 29

Synthesis of 2-(4-Cyano-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

The procedure of Example 17 was followed except that in Step 3, 4-Bromomethyl-benzonitrile was substituted for 4-nitrobenzylbromide, to provide the title compound. $^1\text{H-NMR}$ (CDCl_3); δ 8.24 (s, 1H), 8.18 (dd, 1H), 7.59 (dd, 2H), 7.53 (d, 2H), 7.29 (m, 3H), 6.89 (dd, 2H), 6.49 (bt, 1H), 5.06 (s, 2H), 4.58 (d, 2H), 3.81 (s, 3H), and 3.53 (s, 3H) ppm. Anal. ($\text{C}_{25}\text{H}_{22}\text{N}_4\text{O}_5\text{S}_1$) C,H,N.

MS: $M^+ + 1 = 491.3$ Da

-48-

EXAMPLE 30

Synthesis of {4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-phenyl}-acetic acid

The procedure of Example 17 was followed except that in Step 3,
5 (4-Bromomethyl-phenyl)-acetic acid *tert*-butyl ester was substituted for
4-nitrobenzylbromide. The resulting *t*-butyl ester intermediate was hydrolyzed
following the procedure set forth in Example 11 to provide the title compound.
1^H-NMR (CDCl₃); δ 8.21 (s, 1H), 8.13 (dd, 1H), 7.36 (d, 2H), 7.26 (m, 3H), 7.18
(d, 2H), 6.87 (d, 2H), 6.73 (bt, 1H), 5.02 (s, 2H), 4.54 (d, 2H), 3.79 (s, 3H), 3.58
10 (s, 2H), and 3.50 (s, 3H) ppm. Anal. (C₂₆H₂₅N₃O₇S₁ · 2H₂O) C,H,N.
MS: M⁺ + 1 = 524.2 Da

EXAMPLE 31

Synthesis of 4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1*H*-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid

The procedure of Example 17 was followed except that in Step 2,
15 3-methoxy-benzylamine was substituted for 4-methoxybenzylamine and in Step 3,
4-bromomethyl-benzoic acid *tert*-butyl ester was substituted for
4-nitrobenzylbromide. The resulting *t*-butyl ester intermediate was hydrolyzed
following the procedure set forth in Example 11 to provide the title compound.
20 1^H-NMR (CDCl₃); δ 8.50 (s, 1H), 8.47 (bt, 1H), 8.25 (dd, 1H), 7.88 (d, 2H), 7.37
(d, 2H), 7.23 (d, 1H), 7.16 (t, 1H) 6.87 (d, 1H), 6.83 (s, 1H), 6.72 (dd, 1H), 5.00
(s, 2H), 4.50 (d, 2H), 3.71 (s, 3H), and 3.45 (s, 3H) ppm. Anal. (C₂₅H₂₃N₃O₇S₁ ·
0.25H₂O) C,H,N. MS: M⁺ + 1 = 510.2 Da

EXAMPLE 32

Synthesis of 4-Methyl-1,1,3-trioxo-2-[4-(2*H*-tetrazol-5-yl)-benzyl]-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

The procedure of Example 17 was followed except that in Step 3,
5-(4-Bromomethyl-phenyl)-2-trityl-2*H*-tetrazole was substituted for

-49-

4-nitrobenzylbromide. The trityl product was then hydrolyzed in manner similar to the *t*-butyl hydrolysis set forth in Example 11 to provide the title compound.

¹H-NMR (DMSO-*d*₆); δ 9.27 (bt, 1H), 8.43 (s, 1H), 8.28 (d, 1H), 7.95 (d, 2H), 7.66 (d, 1H), 7.53 (d, 2H), 7.22 (d, 2H) 6.86 (d, 2H), 5.06 (s, 2H), 4.39 (d, 2H), 3.68 (s, 3H), and 3.49 (s, 3H) ppm. Anal. (C₂₅H₂₃N₇O₅S₁ · 0.66H₂O) C,H,N.

MS: M⁺ + 1 = 534.2 Da

EXAMPLE 33

Synthesis of 2-(4-Amino-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1λ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

4-Methyl-2-(4-nitro-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1λ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide (0.6 g, Example 17) was dissolved in 25 mL of glacial acetic acid at room temperature. Powdered zinc (0.77 g) was added in portions and the resulting green mixture was stirred for 2 hours. The reaction was filtered through a pad of Celite, and the solids were washed with ethyl acetate. The filtrate was concentrated to dryness, and the residue was partitioned between 1M sodium hydroxide and ethyl acetate. The organic layer was dried (magnesium sulfate), filtered, and concentrated to give an orange solid. Chromatography (silica, 50% ethyl acetate/hexanes) provide 0.18 g of the title compound. ¹H-NMR (CDCl₃); δ 8.22 (s, 1H), 8.18 (d, 1H), 7.79 (d, 1H), 7.54 (d, 2H), 7.28 (m, 5H) 6.90 (d, 2H), 6.40 (bt, 1H), 5.11 (s, 2H), 4.58 (d, 2H), 3.81 (s, 3H), 3.53 (s, 3H), and 1.56 (bs, 2H) ppm. Anal. (C₂₄H₂₄N₄O₅S₁) C,H,N. MS: M⁺ + 1 = 481.2 Da

EXAMPLE 34

Synthesis of 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1λ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide

The procedure of Example 2 was followed except that 3-methoxybenzylamine was substituted for benzylamine, to provide the title compound. ¹H-NMR (CDCl₃); δ 8.24 (s, 1H), 8.17 (dd, 1H), 7.42 (d, 2H), 7.28

-50-

(m, 5H), 6.90 (m, 3H), 6.51 (bs, 1H), 5.06 (s, 2H), 4.62 (d, 2H), 3.81 (s, 3H), and 3.52 (s, 3H) ppm. Anal. (C₂₄H₂₃N₃O₅S₁) C, H, N. MS: M⁺ + 1 = 466.1 Da

EXAMPLE 35

4-methyl-1,1,3-trioxo-2-pent-2-ynyl-1,2,3,4-tetrahydro-1⁶-**benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide**

In an 8 mL screw cap vial was added a solution of 4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide (0.037 g, 0.1 mmol) in dimethylformamide (1 mL), a solution of 1-Chloro-pent-2-yne (0.023 g, 0.23 mmol) in dimethylformamide (575 mL) and anhydrous cesium carbonate (0.075 g, 0.023 mmol). The vial was capped, and the reaction mixture was shaken for 24 hours at room temperature. The reaction mixture was filtered, and the solvent was removed under vacuum. Purification was carried out via reverse-phase HPLC (3% n-propanol in acetonitrile and 3% n-propanol in water as the eluent; C-18 column) 0.027 g (60% yield).

MS-APCI: M + 1 = 442.1.

In a manner similar to the procedure of Example 35, the compounds of Examples 36 to 47 were prepared.

EXAMPLE 36

4-Methyl-1,1,3-trioxo-2-(1-phenyl-ethyl)-1,2,3,4-tetrahydro-1⁶-**benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide**

MS-APCI (M + 1): 480.5545

EXAMPLE 37

2-(5-Cyano-pentyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-**benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide**

MS-APCI (M + 1): 471.5474

EXAMPLE 38

2-(E)-But-2-enyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-**benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide**

-51-

MS-APCI (M +1): 430.4947

EXAMPLE 39

**4-Methyl-1,1,3-trioxo-2-(E)-pent-2-enyl-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide**

5 MS-APCI (M +1): 444.5215

EXAMPLE 40

**4-Methyl-2-(2-methyl-allyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide**

MS-APCI (M +1): 430.4947

10

EXAMPLE 41

**4-Methyl-2-(3-methyl-but-2-enyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide**

MS-APCI (M +1): 444.5215

EXAMPLE 42

15 **4-Methyl-1,1,3-trioxo-2-[2-(toluene-4-sulfonyl)-ethyl]-1,2,3,4-tetrahydro-1⁶-
benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide**

MS-APCI (M +1): 558.6453

EXAMPLE 43

20 **2-[3-(4-Fluoro-phenyl)-3-oxo-propyl]-4-methyl-1,1,3-trioxo-1,2,3,4-
tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-
benzylamide**

MS-APCI (M +1): 526.5546

EXAMPLE 44

25 **4-Methyl-1,1,3-trioxo-2-{2-[(1-phenyl-methanoyl)-amino]-ethyl}-1,2,3,4-
tetrahydro-1⁶-benz [1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-
benzylamide**

-52-

MS-APCI (M + 1): 523.5794

EXAMPLE 45

2-Benzo[1,2,5]oxadiazol-5-ylmethyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1H-6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

5 MS-APCI (M + 1): 508.5249

EXAMPLE 46

{5-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-6-benzo[1,2,4]thiadiazin-2-ylmethyl]-isoxazol-3-yl}-carbamic acid methyl ester

10 MS-APCI (M + 1): 530.5277

EXAMPLE 47

4-Methyl-1,1,3-trioxo-2-thiazol-4-ylmethyl-1,2,3,4-tetrahydro-1H-6-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide

MS-APCI (M + 1): 473.544

15 The invention compounds of Formula I have been evaluated in standard assays for their ability to inhibit the catalytic activity of various MMP enzymes. The assays used to evaluate the biological activity of the invention compounds are well-known and routinely used by those skilled in the study of MMP inhibitors and their use to treat clinical conditions.

20 The assays measure the amount by which a test compound reduces the hydrolysis of a thiopeptolide substrate catalyzed by a matrix metalloproteinase enzyme. Such assays are described in detail by Ye et al., in *Biochemistry*, 1992;31(45):11231-11235, which is incorporated herein by reference.

25 Thiopeptolide substrates show virtually no decomposition or hydrolysis at or below neutral pH in the absence of a matrix metalloproteinase enzyme. A typical thiopeptolide substrate commonly utilized for assays is Ac-Pro-Leu-Gly-thioester-Leu-Leu-Gly-OEt. A 100 μ L assay mixture will contain 50 mM of N-2-hydroxyethylpiperazine-N'-2-ethanesulfonic acid buffer ("HEPES," pH 7.0),

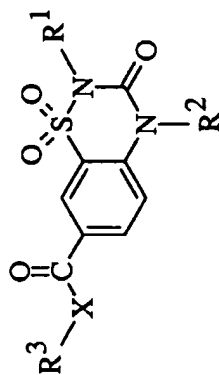
-53-

10 mM CaCl_2 , 100 μM thiopeptolide substrate, and 1 mM 5,5'-dithio-bis-(2-nitro-benzoic acid) (DTNB). The thiopeptolide substrate concentration may be varied from, for example, 10 to 800 μM to obtain K_m and K_{cat} values. The change in absorbance at 405 nm is monitored on a Thermo Max microplate reader
5 (Molecular Devices, Menlo Park, CA) at room temperature (22°C). The calculation of the amount of hydrolysis of the thiopeptolide substrate is based on $E_{412} = 13600 \text{ M}^{-1} \text{ cm}^{-1}$ for the DTNB-derived product 3-carboxy-4-nitrothiophenoxide. Assays are carried out with and without matrix metalloproteinase inhibitor compounds, and the amount of hydrolysis is compared
10 for a determination of inhibitory activity of the test compounds.

Several representative compounds have been evaluated for their ability to inhibit various matrix metalloproteinase enzymes. Tables 1 and 2 below present inhibitory activity for compounds from this invention. In Table 1 and Table 2, MMP-1FL refers to full-length interstitial collagenase; MMP-2FL refers to
15 full-length Gelatinase A; MMP-3CD refers to the catalytic domain of stromelysin-1; MMP-7FL refers to full-length matrilysin; MMP-9FL refers to full-length Gelatinase B; MMP-13CD refers to the catalytic domain of collagenase 3; and MMP-14CD refers to the catalytic domain of MMP-14. Test compounds were evaluated at various concentrations in order to determine their respective
20 IC_{50} values, the micromolar concentration of compound required to cause a 50% inhibition of the catalytic activity of the respective enzyme.

It should be appreciated that the assay buffer used with MMP-3CD was 50 mM of N-morpholinoethane sulfonate ("MES") at pH 6.0 rather than the HEPES buffer at pH 7.0 described above.

Table 1



Ex. No.	R ¹	R ²	X	R ³	MMP01 (FL) IC ₅₀ , μM	MMP02 (CD) IC ₅₀ , μM	MMP02 (FL) IC ₅₀ , μM	MMP03 (CD) IC ₅₀ , μM	MMP07 (FL) IC ₅₀ , μM	MMP09 (FL) IC ₅₀ , μM	MMP13 (CD) IC ₅₀ , μM	MMP14 (CD) IC ₅₀ , μM
1	CH ₂ Ph	CH ₃	O	CH ₂ Ph	>100	>100	>100	85	44	>100	0.2	>100
2	CH ₂ Ph	CH ₃	NH	CH ₂ Ph	>100	>30	>30	>30	>30	>30	0.88	>30
3	CH ₂ Ph	CH ₃	NH	CH ₂ -4-Py	--	--	--	--	--	--	0.51	--

"--" means not tested.

-55-

The inhibition activities of the compounds of Examples 4 to 47 are shown below in Table 2.

Table 2. IC₅₀ (μM) Versus Certain MMPs

(Page 1 of 2)

Example No.	MMP01 (FL)	MMP02 (FL)	MMP03 (CD)	MMP07 (FL)	MMP09 (FL)	MMP13 (CD)	MMP14 (CD)
4	--a	--	--	--	--	>30	--
5	>30	>100	>30	51	>30	0.17	>30
6	--	--	--	--	--	>30	--
7	--	--	--	--	--	>30	--
8	--	--	--	--	--	63	--
9	--	--	--	--	--	30	--
10	--	--	--	--	--	>30	--
11	>100	>100	>100	>100	>100	0.066	>100
12	--	--	--	--	--	>30	--
13	>100	>100	64	>100	>100	0.011	>100
14	>30	--	>100	>30	>30	0.155	>30
15	--	--	--	--	--	11	--
16	>100	--	>100	>30	>30	0.345	>30
17	>30	--	16	>30	>30	0.615	>30
18	>30	--	10	>30	>30	0.31	>30
19	>30	--	11	>30	>30	0.23	>30
20	>30	--	>30	>30	10	0.385	>30
21	>30	--	>30	>30	>30	0.155	>100
22	>30	--	>30	>30	>30	0.62	>30
23	--	--	--	--	--	>30	--
24	>30	--	13	>30	>30	0.125	>30
25	>100	--	>30	>100	>100	0.019	>100
26	--	--	--	--	--	2.2	--

a "--" means data not available.

-56-

Table 2. IC₅₀ (μM) Versus Certain MMPs

(Page 2 of 2)

Example No.	MMP01 (FL)	MMP02 (FL)	MMP03 (CD)	MMP07 (FL)	MMP09 (FL)	MMP13 (CD)	MMP14 (CD)
27	>30	--	10	>30	>30	0.29	>30
28	>100	--	>30	>100	>100	0.25	>100
29	>30	--	9.4	>30	>30	0.13	>30
30	>100	--	>30	82	>100	0.0355	>100
31	>100	--	>30	>30	>100	0.00485	>100
32	>100	--	15	>30	>100	0.0062	>100
33	--	--	--	--	--	8.8	--
34	>30	--	>100	>30	>30	0.0625	>30
35	--	--	--	--	--	1.4	--
36	--	--	--	--	--	6.3	--
37	--	--	--	--	--	3.2	--
38	--	--	--	--	--	2.2	--
39	--	--	--	--	--	1.5	--
40	--	--	--	--	--	1.7	--
41	--	--	--	--	--	1.9	--
42	--	--	--	--	--	100	--
43	--	--	--	--	--	30	--
44	--	--	--	--	--	86	--
45	--	--	--	--	--	0.7	--
46	--	--	--	--	--	1.7	--
47	--	--	--	--	--	13	--

^a "--" means data not available.

The foregoing data in Tables 1 and 2 establish that the invention compounds of Formula I are potent inhibitors of MMP enzymes, and are especially useful due to their selective inhibition of MMP-13. Because of this potent and selective inhibitory activity, the invention compounds are especially useful to treat diseases mediated by the MMP enzymes, and particularly those mediated by MMP-13.

-57-

Administration of a compound of Formula I, or a pharmaceutically acceptable salt thereof, to a mammal to treat diseases mediated by MMP enzymes preferably, although not necessarily, is accomplished by administering the compound, or the salt thereof, in a pharmaceutical dosage form.

5 The compounds of the present invention can be prepared and administered in a wide variety of oral and parenteral dosage forms. Thus, the compounds of the present invention can be administered by injection, that is, intravenously, intramuscularly, intracutaneously, subcutaneously, intraduodenally, or intraperitoneally. Also, the compounds of the present invention can be
10 administered by inhalation, for example, intranasally. Additionally, the compounds of the present invention can be administered transdermally. It will be obvious to those skilled in the art that the following dosage forms may comprise as the active component, either a compound of Formula I or a corresponding pharmaceutically acceptable salt of a compound of Formula I. The active
15 compound generally is present in a concentration of about 5% to about 95% by weight of the formulation.

 For preparing pharmaceutical compositions from the compounds of the present invention, pharmaceutically acceptable carriers can be either solid or liquid. Solid form preparations include powders, tablets, pills, capsules, cachets,
20 suppositories, and dispersible granules. A solid carrier can be one or more substances which may also act as diluents, flavoring agents, solubilizers, lubricants, suspending agents, binders, preservatives, tablet disintegrating agents, or an encapsulating material.

 In powders, the carrier is a finely divided solid which is in a mixture with
25 the finely divided active component.

 In tablets, the active component is mixed with the carrier having the necessary binding properties in suitable proportions and compacted in the shape and size desired.

 The powders and tablets preferably contain from 5% or 10% to about 70%
30 of the active compound. Suitable carriers are magnesium carbonate, magnesium stearate, talc, sugar, lactose, pectin, dextrin, starch, gelatin, tragacanth, methylcellulose, sodium carboxymethylcellulose, a low melting wax, cocoa butter, and the like. The term "preparation" is intended to include the formulation

-58-

of the active compound with encapsulating material as a carrier providing a capsule in which the active component, with or without other carriers, is surrounded by a carrier, which is thus in association with it. Similarly, cachets and lozenges are included. Tablets, powders, capsules, pills, cachets, and lozenges can be used as solid dosage forms suitable for oral administration.

For preparing suppositories, a low melting wax, such as a mixture of fatty acid glycerides or cocoa butter, is first melted and the active component is dispersed homogeneously therein, as by stirring. The molten homogenous mixture is then poured into convenient sized molds, allowed to cool, and thereby to solidify.

Liquid-form preparations include solutions, suspensions, and emulsions, for example, water or water propylene glycol solutions. For parenteral injection, liquid preparations can be formulated in solution in aqueous polyethylene glycol solution.

Aqueous solutions suitable for oral use can be prepared by dissolving the active component in water and adding suitable colorants, flavors, stabilizing, and thickening agents as desired.

Aqueous suspensions suitable for oral use can be made by dispersing the finely divided active component in water with viscous material, such as natural or synthetic gums, resins, methylcellulose, sodium carboxymethylcellulose, and other well-known suspending agents.

Also included are solid-form preparations which are intended to be converted, shortly before use, to liquid-form preparations for oral administration. Such liquid forms include solutions, suspensions, and emulsions. These preparations may contain, in addition to the active component, colorants, flavors, stabilizers, buffers, artificial and natural sweeteners, dispersants, thickeners, solubilizing agents, and the like.

The pharmaceutical preparation is preferably in unit dosage form. In such form, the preparation is subdivided into unit doses containing appropriate quantities of the active component. The unit dosage form can be a packaged preparation, the package containing discrete quantities of preparation, such as packeted tablets, capsules, and powders in vials or ampoules. Also, the unit

-59-

dosage form can be a capsule, tablet, cachet, or lozenge itself, or it can be the appropriate number of any of these in packaged form.

5 The quantity of active component in a unit dose preparation may be varied or adjusted from 1 to 1000 mg, preferably 10 to 100 mg according to the particular application and the potency of the active component. The composition can, if desired, also contain other compatible therapeutic agents.

10 In therapeutic use as agents to inhibit a matrix metalloproteinase enzyme for the treatment of atherosclerotic plaque rupture, aortic aneurysm, heart failure, restenosis, periodontal disease, corneal ulceration, cancer metastasis, tumor angiogenesis, arthritis, or other autoimmune or inflammatory disorders dependent upon breakdown of connective tissue, the compounds utilized in the pharmaceutical method of this invention are administered at a dose that is effective to inhibit the hydrolytic activity of one or more matrix metalloproteinase enzymes. The initial dosage of about 1 mg/kg to about 100 mg/kg daily will be effective. A daily dose range of about 25 mg/kg to about 75 mg/kg is preferred. 15 The dosages, however, may be varied depending upon the requirements of the patient, the severity of the condition being treated, and the compound being employed. Determination of the proper dosage for a particular situation is within the skill of the art. Generally, treatment is initiated with smaller dosages which are less than the optimum dose of the compound. Thereafter, the dosage is increased 20 by small increments until the optimum effect under the circumstance is reached. For convenience, the total daily dosage may be divided and administered in portions during the day if desired. Typical dosages will be from about 0.1 mg/kg to about 500 mg/kg, and ideally about 25 mg/kg to about 250 mg/kg, such that it will be an amount which is effective to treat the particular disease being prevented or controlled. 25

The following examples illustrate typical pharmaceutical compositions provided by the invention.

-60-

FORMULATION EXAMPLE 1

Tablet Formulation

Ingredient	Amount (mg)
Compound of Example 3	25
Lactose	50
Corn starch (for mix)	10
Corn starch (paste)	10
Magnesium stearate (1%)	5
Total	100

5 The benzothiadiazine of Example 3, lactose, and corn starch (for mix) are blended to uniformity. The corn starch (for paste) is suspended in 200 mL of water and heated with stirring to form a paste. The paste is used to granulate the mixed powders. The wet granules are passed through a No. 8 hand screen and dried at 80°C. The dry granules are lubricated with the 1% magnesium stearate and pressed into a tablet. Such tablets can be administered to a human from one to four times a day for treatment of cancer, atherosclerosis, or arthritis.

10

FORMULATION EXAMPLE 2

Preparation for Oral Solution

Ingredient	Amount
Compound of Example 1	400 mg
Sorbitol solution (70% N.F.)	40 mL
Sodium benzoate	20 mg
Saccharin	5 mg
Red dye	10 mg
Cherry flavor	20 mg
Distilled water q.s.	100 mL

-61-

The sorbitol solution is added to 40 mL of distilled water, and the benzothiadiazine of Example 1 is dissolved therein. The saccharin, sodium benzoate, flavor, and dye are added and dissolved. The volume is adjusted to 100 mL with distilled water. Each milliliter of syrup contains 4 mg of invention compound.

FORMULATION EXAMPLE 3

Parenteral Solution

In a solution of 700 mL of propylene glycol and 200 mL of water for injection is suspended 20 g of the compound of Example 2. After suspension is complete, the pH is adjusted to 6.5 with 1N sodium hydroxide, and the volume is made up to 1000 mL with water for injection. The formulation is sterilized, filled into 5.0-mL ampoules each containing 2.0 mL, and sealed under nitrogen.

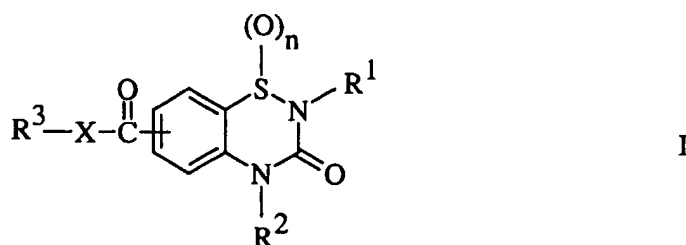
As matrix metalloproteinase inhibitors, the compounds of Formula I are useful as agents for the treatment of multiple sclerosis. They are also useful as agents for the treatment of atherosclerotic plaque rupture, restenosis, periodontal disease, corneal ulceration, treatment of burns, decubital ulcers, wound repair, heart failure, cancer metastasis, tumor angiogenesis, arthritis, and other inflammatory disorders dependent upon tissue invasion by leukocytes. The MMP inhibitors of Formula I are especially useful for treating rheumatoid arthritis, osteoarthritis, and congestive heart failure.

-62-

CLAIMS

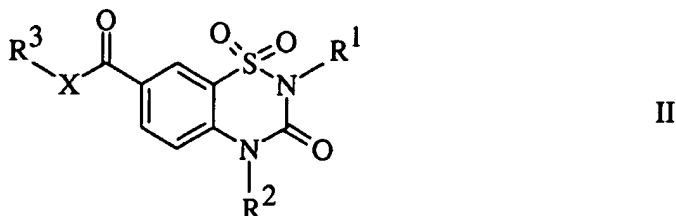
What is claimed is:

1. A compound of Formula I



- 5 or a pharmaceutically acceptable salt thereof, wherein:
 n is 0, 1, or 2;
 X is O or NH;
 R² is H, C₁-C₆ alkyl, or C₁-C₆ substituted alkyl;
 R¹ and R³ independently are H, acyl, substituted acyl, C₁-C₆ alkyl,
 10 C₁-C₆ substituted alkyl, C₂-C₆ alkenyl, C₂-C₆ substituted alkenyl,
 C₂-C₆ alkynyl, C₁-C₆ substituted alkynyl, (CH₂)_m aryl,
 (CH₂)_m substituted aryl, (CH₂)_m heteroaryl, (CH₂)_m substituted
 heteroaryl, (CH₂)_m cycloalkyl, or (CH₂)_m substituted cycloalkyl;
 and
 15 each m independently is an integer of from 0 to 6,
 with the proviso that R³ is not (CH₂)_m biphenyl or (CH₂)_m substituted
 biphenyl.

2. A compound of Formula II



- 20 or a pharmaceutically acceptable salt thereof, wherein:
 X is O or NH;

-63-

R^2 is H, or C_1 - C_6 alkyl, or C_1 - C_6 substituted alkyl;

R^1 and R^3 independently are H, acyl, substituted acyl, C_1 - C_6 alkyl,

C_1 - C_6 substituted alkyl, C_2 - C_6 alkenyl, C_2 - C_6 substituted alkenyl,

C_2 - C_6 alkynyl, C_1 - C_6 substituted alkynyl, $(CH_2)_m$ aryl, $(CH_2)_m$

5 substituted aryl, $(CH_2)_m$ heteroaryl, $(CH_2)_m$ substituted

heteroaryl, $(CH_2)_m$ cycloalkyl, or $(CH_2)_m$ substituted cycloalkyl;

and

each m independently is an integer of from 0 to 6,

with the proviso that R^3 is not $(CH_2)_m$ biphenyl or $(CH_2)_m$ substituted

10 biphenyl.

3. A compound selected from:

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-

1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid benzyl ester;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-

15 1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-

1/6-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-

benzo[1,2,4]thiadiazine-7-carboxylic acid (1H-indol-5-ylmethyl)-amide;

20 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-

benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-

benzo[1,2,4]thiadiazine-7-carboxylic acid 4-(2-*tert*-butylsulfamoyl-ethyl)-benzylamide;

25 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-

benzo[1,2,4]thiadiazine-7-carboxylic acid (1H-indol-2-ylmethyl)-amide;

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1/6-

benzo[1,2,4]thiadiazine-7-carboxylic acid 4-(2-sulfamoyl-ethyl)-benzylamide;

-64-

- 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;
- 4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1 β -benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 5 4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1 β -benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1 β -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid *tert*-butyl ester;
- 10 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1 β -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid;
- 2-(4-Carbamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 15 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-fluoro-benzylamide;
- 4-Methyl-2-(4-nitro-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 20 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 4-Methyl-2-[4-(morpholine-4-sulfonyl)-benzyl]-1,1,3-trioxo-1,2,3,4-tetrahydro-1 β -benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 25 4-[7-(4-Fluoro-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1 β -benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid methyl ester;

-65-

2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (2-methoxy-pyridin-4-ylmethyl)-amide;

5 4-Methyl-2-naphthalen-2-ylmethyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-Biphenyl-4-ylmethyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

10 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (2,1,3-benzothiadiazol-5-ylmethyl)-amide;

4-[7-(4-Fluoro-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid;

15 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid 2-dimethylamino-ethyl ester hydrochloride;

4-Methyl-1,1,3-trioxo-2-[4-(piperidine-1-carbonyl)-benzyl]-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

20 2-{4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoylamino}-3-methyl-butyric acid;

2-(4-Cyano-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

25 {4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-phenyl}-acetic acid;

4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-benzoic acid;

30 4-Methyl-1,1,3-trioxo-2-[4-(2H-tetrazol-5-yl)-benzyl]-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

-66-

- 2-(4-Amino-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;
- 5 4-Methyl-1,1,3-trioxo-2-pent-2-ynyl-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 4-Methyl-1,1,3-trioxo-2-(1-phenyl-ethyl)-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 10 2-(5-Cyano-pentyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-(E)-But-2-enyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 4-Methyl-1,1,3-trioxo-2-(E)-pent-2-enyl-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 15 4-Methyl-2-(2-methyl-allyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 4-Methyl-2-(3-methyl-but-2-enyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 20 4-Methyl-1,1,3-trioxo-2-[2-(toluene-4-sulfonyl)-ethyl]-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-[3-(4-Fluoro-phenyl)-3-oxo-propyl]-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 25 4-Methyl-1,1,3-trioxo-2-{2-[(1-phenyl-methanoyl)-amino]-ethyl}-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-Benzo{1,2,5}oxadiazol-5-ylmethyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1 λ ⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 30

-67-

{5-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl]-isoxazol-3-yl}-carbamic acid methyl ester; and

5 4-Methyl-1,1,3-trioxo-2-thiazol-4-ylmethyl-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide.

4. A compound selected from:

- 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;
- 10 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-Benzyl-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-1⁶-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;
- 15 4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid tert-butyl ester;
- 4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid tert-butyl ester;
- 20 4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid tert-butyl ester;
- 4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid *tert*-butyl ester;
- 25 4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid tert-butyl ester;
- 4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;
- 30 4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1H-1⁶-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;

-68-

4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;

4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;

5 4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;

{4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid tert-butyl ester;

10 {4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid tert-butyl ester;

{4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid tert-butyl ester;

15 {4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid tert-butyl ester;

20 {4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid tert-butyl ester;

{4-(7-Benzylcarbamoyl-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;

{4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;

25 {4-(4-Methyl-1,1,3-trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;

{4-[7-(4-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;

30 {4-[7-(3-Methoxy-benzylcarbamoyl)-4-methyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;

2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

-69-

2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;

5 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;

2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxybenzylamide;

10 2-(4-Methanesulfonyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxybenzylamide;

4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

15 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;

4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;

20 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxybenzylamide;

25 4-Methyl-2-(4-methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxybenzylamide;

2-(4-Dimethylsulfamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

30 2-(4-Dimethylsulfamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;

-70-

2-(4-Dimethylsulfamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;

5 2-(4-Dimethylsulfamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-(4-Dimethylsulfamoyl-benzyl)-4-methyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;

10 2-Benzyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

2-Benzyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;

15 2-Benzyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;

2-Benzyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;

2-Benzyl-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;

20 4-(7-Benzylcarbamoyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid tert-butyl ester;

4-(1,1,3-Trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid tert-butyl ester;

25 4-(1,1,3-Trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid tert-butyl ester;

4-[7-(4-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid tert-butyl ester;

4-[7-(3-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid tert-butyl ester;

30 4-(7-Benzylcarbamoyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;

4-(1,1,3-Trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;

-71-

4-(1,1,3-Trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;

4-[7-(4-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;

5 4-[7-(3-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-benzoic acid;

{4-(7-Benzylcarbamoyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid tert-butyl ester;

10 {4-(1,1,3-Trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid tert-butyl ester;

{4-(1,1,3-Trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid tert-butyl ester;

15 {4-[7-(4-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid tert-butyl ester;

20 {4-[7-(3-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid tert-butyl ester;

{4-(7-Benzylcarbamoyl-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;

{4-(1,1,3-Trioxo-7-[(pyridin-4-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;

25 {4-(1,1,3-Trioxo-7-[(pyridin-3-ylmethyl)-carbamoyl]-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;

{4-[7-(4-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;

30 {4-[7-(3-Methoxy-benzylcarbamoyl)-1,1,3-trioxo-3,4-dihydro-1H-116-benzo[1,2,4]thiadiazin-2-ylmethyl)-phenyl}-acetic acid;

2-(4-Methanesulfonyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;

-72-

- 2-(4-Methanesulfonyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;
- 2-(4-Methanesulfonyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;
- 5 2-(4-Methanesulfonyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-(4-Methanesulfonyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;
- 10 2-(4-Methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;
- 2-(4-Methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;
- 2-(4-Methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;
- 15 2-(4-Methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- 2-(4-Methylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide;
- 20 2-(4-Dimethylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid benzylamide;
- 2-(4-Dimethylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-4-ylmethyl)-amide;
- 2-(4-Dimethylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid (pyridin-3-ylmethyl)-amide;
- 25 2-(4-Dimethylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 4-methoxy-benzylamide;
- and
- 2-(4-Dimethylsulfamoyl-benzyl)-1,1,3-trioxo-1,2,3,4-tetrahydro-116-benzo[1,2,4]thiadiazine-7-carboxylic acid 3-methoxy-benzylamide.
- 30 5. A pharmaceutical composition, comprising a compound of Claim 1, or a pharmaceutically acceptable salt thereof, admixed with a pharmaceutically acceptable carrier, diluent, or excipient.

-73-

6. A pharmaceutical composition, comprising a compound of Claim 2, or a pharmaceutically acceptable salt thereof, admixed with a pharmaceutically acceptable carrier, diluent, or excipient.
- 5 7. Use of a compound of Claim 1, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of a disease mediated by an MMP-13 enzyme.
8. Use of a compound of Claim 2, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of a disease mediated by an MMP-13 enzyme.
- 10 9. Use of a compound of Formula I, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of cancer; or
Use of a compound of Formula I, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of rheumatoid arthritis; or
- 15 Use of a compound of Formula I, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of osteoarthritis; or
Use of a compound of Formula I, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of
- 20 congestive heart failure.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 02/00083

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C07D285/24 A61P35/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07D A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 49692 A (NOVONORDISK AS) 31 December 1997 (1997-12-31) example 125(a); page 14, line 4, intermediate for preparation (cf. example 125)	1,2
A	US 5 948 780 A (PETERSON JR JOSEPH THOMAS ET AL) 7 September 1999 (1999-09-07) cited in the application column 1, line 10 -column 1, line 14 column 4, line 45 -column 10, line 53	1-9
A	WO 98 49146 A (NAKAGAWA KAZUHIKO ;DENT BARRY ROY (NZ); US HEALTH (US); KELLEY MIC) 5 November 1998 (1998-11-05) page 1, line 5 -page 1, line 7; claims 1-57	1-9



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents:

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the International filing date

L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

S document member of the same patent family

Date of the actual completion of the international search

19 March 2002

Date of mailing of the international search report

27/03/2002

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Schmid, A

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IB 02/00083

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9749692	A	31-12-1997	AU 737920 B2	06-09-2001
			AU 3166497 A	14-01-1998
			BR 9709858 A	10-08-1999
			CA 2258100 A1	31-12-1997
			CZ 9804131 A3	16-06-1999
			WO 9749692 A1	31-12-1997
			EP 0906297 A1	07-04-1999
			HU 9904032 A2	28-03-2000
			JP 2000512641 T	26-09-2000
			NO 985979 A	19-02-1999
			PL 330815 A1	07-06-1999
			US 6242443 B1	05-06-2001
			ZA 9705496 A	04-02-1998
US 5948780	A	07-09-1999	AU 741768 B2	06-12-2001
			AU 5590698 A	03-07-1998
			BR 9714385 A	16-05-2000
			EP 1028716 A1	23-08-2000
			JP 2001526631 T	18-12-2001
			NO 992769 A	09-08-1999
			WO 9825597 A2	18-06-1998
			ZA 9711004 A	05-10-1998
WO 9849146	A	05-11-1998	AU 736979 B2	09-08-2001
			AU 7469898 A	24-11-1998
			EP 0977738 A2	09-02-2000
			WO 9849146 A2	05-11-1998